Volume 22, Number 14, July 31, 1968

NUCLEAR SCIENCE ABSTRACTS

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Index References

All index entries refer the reader to volume and abstract number:

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FOURRIER, Alain
  Radioactive chain of mass number 189,  21:10023
```

Personal Authors

Every author's name is indexed in the form appearing on the document abstracted:

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MONTH, M.
  Theory of gradient perturbations in AGS,  21:9872 (BNL-
    10899)
MONTH, Melvin
  Simple relativistic calculation of the electromagnetic
    form factors of the deuteron,  21:9744
```

Subjects

The subject index consisting of specific materials, objects, and processes is arranged alphabetically. Modifying phrases specific to these subjects in turn are arranged alphabetically under the subjects.

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SHEEP
  radiation dosimetry in, measurement of lethal dose of x,
    21:8905(R) (AD-631189)
  radiosensitivity of hematopoietic system of, x,
    21:8905(R) (AD-631189)
```

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SHELTERS
  construction of, for civil defense,  21:8838
  design of fallout,  21:8777(R) (AD-629736)
  design of shaft closure for,  21:8563(P)
  determination of configuration of, for ventilation,
    21:8779(R) (AD-629928)
  equipment for fallout, minimal requirements of,
    21:8782(R) (AD-631424)
  evaluation of fallout, for fire and air blast damage,
    21:8560 (URS-658-3)
  fire resistance of components of, evaluation of,
    21:8789(R) (AD-642241)
```

Corporate Authors

Technical report literature is indexed from the name of the organization or institution responsible for the issuance of the report.

8500 (Y-1561) MIXING AND SAMPLING ENRICHED ^{235}U FLUIDS IN CYLINDRICAL STORAGE CONTAINERS. Final Report. Harrell, J. E. **(Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant).** Jan. 17, 1967. Contract W-7405-eng-26. 124p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

is indexed as:

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UNION CARBIDE CORP., OAK RIDGE, TENN.  Y-12 PLANT.
  Mixing and sampling enriched 235U fluids in cylindrical
    storage containers,  21:8500 (Y-1561)
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Report Numbers

Technical report literature is also indexed by report numbers. This index includes information on where individual reports may be obtained. While not reports, patents and conference papers are indexed here as a matter of convenience.

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TID-
  3311(Suppl.  21-8567   Dep. mn. CFSTI $3.00 cy, $0.65 mn
    2)
  22298        21-9915   Nucl. News, 9: No. 12, 17-21 (Dec.
                           1966)
  22298        21-9914   Nucl. News, 10: No. 1, 17-20(Jan.
                           1967)
  23267        21-9702   Phys. Rev., 152: 1171-82(Dec. 23,
                           1966)
  23287        21-8498   Dep. mn. CFSTI $3.00 cy, $0.65 mn
  23420        21-8764   Lancet, 2: 672-5(Sept. 24, 1966)
  23474        21-8528   Dep. mn. CFSTI $3.00 cy, $0.65 mn
  23478        21-8641   Dep. mn. CFSTI $3.00 cy, $0.65 mn
  23482        21-9471   Dep. mn. CFSTI $3.00 cy, $0.65 mn
```

TABLE OF CONTENTS

Volume 22, Number 14, July 31, 1968

Category	Page
CHEMISTRY	2821
Analytical Chemistry	2821
Inorganic, Organic, and Physical Chemistry	2830
Radiation and Nuclear Chemistry	2843
Radiochemistry	2854
Separation Processes	2854
EARTH SCIENCES	2860
Geology and Hydrology	2860
Meteorology	2862
Mineralogy and Exploration	2863
Oceanography	2864
Seismology	2865
ENGINEERING	2866
Nuclear Explosions	2866
Facilities and Equipment	2866
Heat Transfer and Fluid Flow	2870
Isotope Technology	2872
Materials Testing	2874
Protective Structures	2874
Radioactive Material Handling	2874
Vacuum Engineering	2876
INSTRUMENTATION	2877
Radiation Detection Instruments	2877
General Detectors and Monitors	2877
Nuclear Spectroscopic Instrumentation	2883
High Energy Physics Instrumentation	2886
Radiation Dosimeters	2887
Radiometric Instruments	2888
Miscellaneous Instruments and Components	2890
Radiation Effects on Instruments and Instrument Components	2895
LIFE SCIENCES	2897
Biochemistry, Physiology, and Molecular Biology	2897
Ecology	2911
Genetics and Cytogenetics	2911
Health Physics and Safety	2917
Medicine	2927
Radiation Effects on Animals	2937
Radiation Effects on Plants	2947
Radiation Effects on Microorganisms	2949
Radiosterilization and Radiopreservation	2950
METALS, CERAMICS, AND OTHER MATERIALS	2952
Metals and Alloys	2952
Corrosion and Erosion	2952
Preparation and Fabrication	2954
Properties Evaluations	2956
Structure and Phase Studies	2961
Radiation Effects	2964
Ceramics and Cermets	2969
Preparation and Fabrication	2970
Properties Evaluations	2972
Structure and Phase Studies	2974
Radiation Effects	2976
Plastics and Other Materials	2977
PHYSICS (GENERAL)	2979
Astrophysics and Cosmology	2979
Atomic and Molecular Physics	2995
Cosmic Radiation	3009
Direct Energy Conversion	3011
Fluid Physics	3011

Category	Page
PHYSICS (GENERAL) *cont'd.*	
Geophysics	3012
Low-Temperature Physics	3018
Plasma and Thermonuclear Physics	3025
Confinement and Heating of Plasma	3025
Diagnostics of Plasma	3026
Kinetics of Plasma	3027
Production of Plasma	3032
Stability of Plasma	3032
Shielding	3033
Solid-State Physics	3033
Theoretical Physics	3039
PHYSICS (HIGH ENERGY)	3041
Particle Interactions and Properties (Experimental)	3041
Electromagnetic	3041
Weak	3041
Strong (Baryon-Induced)	3041
Strong (Meson-Induced)	3042
Particle Interactions and Properties (Theoretical)	3044
General	3044
Electromagnetic	3045
Weak	3046
Strong (General)	3047
Strong (Baryon No. = 0)	3047
Strong (Baryon No. = 1)	3048
Strong (Baryon No. ≥ 2)	3049
Particle Invariance Principles and Symmetries	3050
General	3050
Applications (Electromagnetic and Weak)	3051
Applications (Strong)	3051
Field Theories	3052
General	3052
Quantum Field Theory	3052
Gravitation and General Relativity	3053
Scattering Theory	3054
Particle Accelerators	3055
PHYSICS (NUCLEAR)	3061
Neutron Interactions with Matter	3061
Nuclear Properties and Reactions, $A \leq 5$	3070
Nuclear Properties and Reactions, $6 \leq A \leq 19$	3071
Nuclear Properties and Reactions, $20 \leq A \leq 89$	3075
Nuclear Properties and Reactions, $A \geq 90$	3079
Nuclear Theory	3085
REACTOR TECHNOLOGY	3093
Central Power Reactors	3093
Marine and Portable Power Reactors	3111
Rocket and Space Reactors	3111
Process Heat and Desalination Reactors	3112
Research and Test Reactors and Critical Assemblies	3113
Reactor Theory, Components, Fuels, and Accessories	3118
GENERAL	3125
CORPORATE AUTHOR INDEX	INDEX-1
PERSONAL AUTHOR INDEX	INDEX-8
SUBJECT INDEX	INDEX-85
REPORT NUMBER INDEX	INDEX-229

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NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical Chemistry

Refer also to abstracts 27625, 27694, 27898, 27902, 27938, 28163, 28194, 28196, 28207, 29800, 29926, and 30155.

27528 (AAEC/TM-427) THE DETERMINATION OF FISSION PRODUCT LEVELS IN HIFAR HEAVY WATER. Palmer, A. R.; Porritt, R. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Jan. 1968. 14p. Dep.

Methods for determination of ^{140}Ba and ^{131}I are described. These methods are suitable for routine monitoring of fission product levels in the HIFAR heavy water circuit. The results obtained over a four-month period are presented and discussed. (auth)

27529 (CEA-N-816) RAPPORT SEMESTRIEL DU DEPARTEMENT DE CHIMIE, JUIN-NOVEMBRE 1966. (Semiannual Report of the Chemistry Department, June-November 1966). (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Sept. 1967. 488p. (In French). Dep.

Twelve sections are included; separate abstracts were prepared for 11. One section on miscellaneous studies on continuous filtration and elimination of sea water incrusting compounds was not in scope for NSA. (P.C.H.)

For abstracts of individual sections see: 27530, 27619, 27620, 27845-27851, and 28732.

27530 (CEA-N-816, pp 9-65) ANALYSES CHIMIQUES. (Chemical Analyses). (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). (In French).

Developments are reported for studies on: analyses in connection with Pu; preparation of irradiated fuel solutions or reconstituted solutions (U and Pu) with a view to analysis; chemical and electrochemical analysis in solution; development in spectrometry — optical emission, atomic absorption, and x-ray fluorescence; gas analysis; chemical analysis in solution; beryllium analysis; active products analysis; study, carrying into effect, and maintenance of analytical apparatus; nuclear materials control; nuclear fuels analysis; and Cadarache analytical laboratory. (P.C.H.)

27531 (GAT-T-1328) ANALYTICAL PROCEDURES FOR THE DETERMINATION OF URANIUM. Voss, F. S.; Trivisonno, C. F. (Goodyear Atomic Corp., Piketon, Ohio). Apr. 23, 1968. Contract AT(33-2)-1. 9p. (CONF-680506-1). Dep. CFSTI.

From 9th Annual Meeting of the Institute of Nuclear Materials Management, Chicago, Ill.

Analytical methods for the determination of U in a variety of accountability materials are described. Some of the methods are applicable when highly accurate results are required to account for the U content of large quantities of material; others are used when less accurate and less expensive analyses are required. A summary of the range of analytical precisions for the determination of U in various materials is tabulated. (P.C.H.)

27532 (GEAP-5344) ELECTRON PROBE MICROANALYSIS OF RADIOACTIVE MATERIALS. I. PRELIMINARY EXPERIMENTS AND PLANS FOR A SHIELDED FACILITY. Rosenbaum, H. S.; Lauritzen, T. A.; Cummings, W. V.; Peterson, R. T. (General Electric Co., Sunnyvale, Calif. Advanced Products Operation). June 30, 1967. Contract AT(04-3)-189. 60p. Dep. CFSTI.

Analytical studies of the behavior of fuels for fast breeder reactors benefit from electron probe microanalysis in determining the distribution of elements in the fuel, in the cladding, and in the regions where the fuel and cladding interact. Experiments in which a standard commercial electron probe microanalyzer was used on fuel and stainless steel cladding specimens whose total γ activity $\leq$50 mR/h at 1 foot are described; the data are relevant to the design of a shielded facility for the analysis of specimens of much higher γ activity. A detailed description of a shielded facility, including techniques developed to prepare, to handle, and to analyze unirradiated alpha-toxic materials and highly irradiated materials, is presented. Analytical limitations due to radioactivity are described. (auth)

27533 (JEN-187-DQ/I-63) ANALISIS ESPECTROGRAFICO DE ALEACIONES URANIO-MOLIBDENO. (Spectrographic Analysis of Uranium-Molybdenum Alloys). Roca, Miguel (Junta de Energia Nuclear, Madrid (Spain). Division de Quimica). 1967. 9p. (In Spanish). Dep.

A spectrographic method of analysis was developed for uranium-molybdenum alloys containing up to 10% Mo. The carrier distillation technique, with gallium oxide and graphite as carriers, is used for the semiquantitative determination of Al, Cr, Fe, Ni, and Si, involving the conversion of the samples into oxides. As a consequence of the study of the influence of the molybdenum on the line intensities, only one set of standards, with 0.6% MoO_3, is prepared. Total burning excitation is used for calcium, employing two sets of standards with 0.6 and 7.5% MoO_3. A carefully controlled conversion of the samples into oxides, at 550°C, is necessary for the quantitative determination of molybdenum, to avoid losses of Mo and to get the total conversion of the uranium into U_3O_8. The samples are diluted with graphite (1 : 9), using cobalt as internal standard, and dc arc total burning excitation. The standard deviation is $\pm$8% and the results are in good agreement with those obtained by chemical methods. (auth)

27534 (NBS-TN-421) RADIOCHEMICAL ANALYSIS: NUCLEAR INSTRUMENTATION, RADIATION TECHNIQUES, NUCLEAR CHEMISTRY, RADIOISOTOPE TECHNIQUES, JULY 1966 THROUGH JUNE 1967. DeVoe, James R. (ed.) (National Bureau of Standards, Washington, D. C.). Nov. 1967. 91p. GPO $0.50.

Research progress is reported on: Moessbauer spectroscopy, nuclear chemistry, nuclear instrumentation, and the application of statistics in nuclear and analytical chemistry. Design of a transducer that is more compact than the previous design was made so that low-temperature experiments can be more easily performed. A method of simultaneously measuring two spectra with a single transducer was devised. A single line ^{61}Ni source was made and the magnetic moment of the excited $^{5}/_{2}$ state measured with this source. Efforts were continued on the interpretation of the spectral parameters and their relation to structure analysis. Studies are continuing on the production of a standard for chemical shift of tin compounds. Equipment is in the final state of assembly and initial testing for measuring cross sections of reactions such as $(\gamma,^{3}He)$ or $(\gamma,^{4}He)$ by mass spectrometry of the reaction products. The practical operation of Ge(Li) and Si(Li) detectors was evaluated. Careful control of preamplifier noise and response is required for optimum performance. A study of the precision and accuracy of gamma-excited x-ray fluorescence was made. Using as a basis the analysis of certified Standard Reference Materials, an improvement of a factor of two in precision was measured. The major advantage concluded from this work is that if rapid analysis requiring portability is desired, the radioisotopic source approach is useful. (auth)

27535 (NIM–129) POLAROGRAPHIC DETERMINATION OF TOTAL HEXAVALENT URANIUM AS URANYL FLUORIDE IN URANOUS FLUORIDE. Jacobs, J. J.; Faure, P. K. (National Inst. for Metallurgy, Johannesburg (South Africa)). Dec. 2, 1966. 20p. Dep.

The dc and ac polarographic behavior of U(VI) in varying amounts of phosphoric and perchloric acids is described. The U(VI) wave was more sensitive in a mixture of these acids than in phosphoric acid alone. Fluoride and nitrate ions had no effect on the sensitivity when present in moderate amounts. The details of a method are given for determination of total hexavalent uranium as uranyl fluoride in uranous fluoride when a mixture of phosphoric and perchloric acids is used as the supporting electrolyte. (auth)

27536 (NIM–138) DETERMINATION OF BERYLLIUM BY ATOMIC-ABSORPTION SPECTROPHOTOMETRY. Taylor, J. D.; Faure, P. K.; Steele, T. W. (National Inst. for Metallurgy, Johannesburg (South Africa)). May 23, 1967. 18p. Dep.

The development of a method for the determination of beryllium in silicate samples is described. The method employs extraction of beryllium, as cupferrate, into a fixed volume of butyl acetate from a solution with a pH value of 6.4 containing EDTA. The absorption is measured in an acetylene and nitrous oxide flame while the organic phase is being aspirated. When a sample weight of 1 g is used, the sensitivity of the method is ~0.2 ppM Be in the solid sample. The coefficient of variation is 1.84% at a concentration of 0.03% BeO. (auth)

27537 (NIM–152) DETERMINATION OF BERYLLIUM BY IRRADIATION WITH GAMMA RAYS. Knight, A.; Watterson, J. I. W.; Uken, E-A.; Faure, P. K. (National Inst. for Metallurgy, Johannesburg (South Africa)). Mar. 22, 1967. 21p. Dep.

A simple instrument that has been built for the determination of beryllium by the well-known photoneutron method is described. Samples are irradiated with gamma rays from an antimony-124 source, and the resultant photoneutrons are detected by boron trifluoride neutron counters. Results are given for samples and standards that contain up to 0.6 per cent BeO. (auth)

27538 (NIM–153) THE SPECTROGRAPHIC DETERMINATION OF ZIRCONIUM IN URANIUM OXIDE. Laboratory Method No. 40/5. van Niekerk, Gerda M.; Watson, A. E.; Eddy, B. T.; Steele, T. W. (National Inst. for Metallurgy, Johannesburg (South Africa)). Mar. 20, 1967. 5p. Dep.

The uranium oxide is mixed with 0.3% lanthanum oxide as an internal standard and 10% mixed carrier consisting of 5 parts of silver chloride to 1 part of sodium fluoride. Samples of the mixture are packed into a Scribner-type electrode and spectrograms are taken in an argon–oxygen atmosphere. (M.C.G.)

27539 (NIM–156) PRELIMINARY OBSERVATIONS ON THE AUTOMATION OF THE TBP METHOD FOR DETERMINING URANIUM. Lowe, K.; Faure, P. K. (National Inst. for Metallurgy, Johannesburg (South Africa)). Apr. 12, 1967. 19p. Dep.

The results of a preliminary investigation of the possibility of using the Technicon AutoAnalyzer system for automating the analysis of uranium samples by the tri-n-butyl phosphate (TBP) method are given. Various problems on the chemical side dealing with the conversion of the manual method to an automated method are described, and possible solutions to these problems are outlined. On the physical side, details are given of the experience gained in getting the equipment to perform its designed function satisfactorily, with special reference to the requirements of the TBP method. (auth)

27540 (NIM–162) GROWTH OF RADIOACTIVITY IN URANIUM AFTER SEPARATION FROM ITS DAUGHTER PRODUCTS. Watterson, J. I. W.; Faure, P. K. (National Inst. for Metallurgy, Johannesburg (South Africa)). Apr. 27, 1967. 13p. Dep.

The radioactivity emitted by pure uranium, and features of its growth to equilibrium, are described. Gamma spectra from newly separated uranium, eight-months-old uranium, and an ore containing uranium in equilibrium with its daughter products, are compared. Some of the consequences for radiometric determination of uranium are described. (auth)

27541 (NIM–163) THE FLUORIMETRIC DETERMINATION OF URANIUM. Laboratory Method No. 92/47. Steele, T. W.; Robert, R. V. D. (National Inst. for Metallurgy, Johannesburg (South Africa)). July 19, 1967. 10p. Dep.

Small amounts of uranyl nitrate were extracted into ethyl acetate in the presence of aluminum nitrate, which acts as a salting out agent. An aliquot portion of the organic layer is pipetted onto a pellet of sodium fluoride contained in a platinum dish, evaporated, and fused. The fluorescence of the fused cake is measured with a fluorimeter and compared with standard samples carried through the procedure with each fusion. The method is applicable to solutions and ores with a low uranium content. The lower limits of determination are 0.00003 g/l and 0.001% for solutions and ores, respectively. (M.C.G.)

27542 (NIM–167) THE DETERMINATION OF THIOCYANATE IN URANIUM SOLUTIONS. Laboratory Method No. 7/20. Danse, A.; Cook, E. B. T.; Stoch, H.; Steele, T. W. (National Inst. for Metallurgy, Johannesburg (South Africa)). Apr. 24, 1967. 4p. Dep.

The procedure consists of passing the solution through a cation-exchange resin in the hydrogen form. The thiocyanate is determined in the eluate by the reaction with ferric chloride and spectrophotometric measurement of the red ferric thiocyanate complex. (P.C.H.)

27543 (NIM–173) THE DETERMINATION OF BERYLLIUM BY ATOMIC-ABSORPTION SPECTROPHOTOMETRY. Laboratory Method No. 4/4. Taylor, J. D.; Steele, T. W. (National Inst. for Metallurgy, Johannesburg (South Africa)). May 15, 1967. 5p. Dep.

The sample is decomposed by a mixture of HCl, HF, H_2SO_4, and $HClO_4$. The beryllium is extracted with an accurately measured volume of n-butyl acetate from a solution at pH 6.4 that contains EDTA. The organic phase is aspirated into a nitrous oxide flame, the absorption measured, and the beryllium concentration is calculated by comparison with standard beryllium solutions treated in a similar manner. The method is applicable to the determination of more than 1 ppM in silicate and ore samples. (M.C.G.)

27544 (NLCO–1015) SUMMARY TECHNICAL REPORT FOR THE PERIOD JANUARY 1, 1968 TO MARCH 31, 1968. Burgett, R. (ed.) (National Lead Co. of Ohio, Cincinnati). May 1968. Contract AT(30-1)-1156. 26p. Dep. CFSTI.

Developments are reported for studies on: mass spectrometric determination of ^{236}U in UF_6 samples using the double-standard interpolative method; effects of dilute alloys on the thermal expansion tensor of α-uranium; high-temperature tensile, drop hammer, and hardness tests on cast U-base dilute quaternary alloys; and reduction in machining stock on rolled uranium rods. In the first study the method of analysis was extended by the use of standards having a wider range. The coefficient of expansion of the crystallographic b axis was found to be the most sensitive to dilute alloying additions of Al and Si. Cast U alloys containing 1000 ppM or less of each of three of the following elements: C, Fe, Si, and Al, were tested at temperatures ranging from 885 to 1200°F. A reduction in the machining stock allowance on rolled uranium rods increased the yield of acceptable cores per ingot. (P.C.H.)

27545 (ORNL–3904(Rev.2)) CUMULATIVE INDEXES TO THE ANALYTICAL CHEMISTRY DIVISION ANNUAL PROGRESS REPORTS, 1964–1967. Raaen, Helen P.; Klein, Ann S. (eds.) (Oak Ridge National Lab., Tenn.). Mar. 1968. Contract W-7405-eng-26. 141p. Dep. CFSTI.

27546 (PEL–162) ABSOLUTE STANDARDISATION OF PURE BETA-EMITTERS BY THE EFFICIENCY TRACING TECHNIQUE. Smit, M. C. B. (Atomic Energy Board, Pelindaba, Pretoria (South Africa)). Aug. 1967. 11p. Dep.

A new method to standardize pure β-emitting nuclides using a modified efficiency tracing technique was developed. By using external absorbers to decrease the counting efficiency, inaccuracies due to differential self-absorption are eliminated and a suitable tracer can be selected irrespective of its chemical compatibility with the β emitter. A theory is developed in which the absorption corrections are made by the use of the efficiency ratio for the particular nuclide pair. (auth)

27547 ACCURATE DETERMINATION OF MICROGRAM QUANTITIES OF URANIUM BY DIRECT AND DIFFERENTIAL POLAROGRAPHY. Verdingh, V.; Lauer, K. F. (Central Bureau for Nuclear Measurements, Geel, Belg.). Z. Anal. Chem., 235: 311-17(1968).

A procedure for the accurate determination of small amounts of pure uranium (5–1,000 μg) by direct or comparative polarography is described. The accuracies obtainable for different total quantities are given. A comparison of the results showed good agreement with the theoretical value even when the number of measurements was small. (P.C.H.)

27548 APPLICATION OF COINCIDENCE COUNTING TO NEUTRON ACTIVATION ANALYSIS. Greenland, L. Paul. U. S., Geol. Surv., Prof. Pap. 600-B, 76-8(1968).

A fast coincidence-counting technique was used to simplify the determination of cobalt and cesium in silicate rocks. After neutron irradiation, ^{60}Co activity was counted directly in the sample with no chemical separations. ^{134}Cs activity was counted after a rapid chemical separation from scandium. Analyses of

eight U. S. Geological Survey standard rock reference samples by this technique are presented. (auth)

27549 DETERMINATION OF MICRO AMOUNTS OF CESIUM IN GEOLOGIC MATERIALS. Mountjoy, Wayne; Wahlberg, James S. U. S., Geol. Surv., Prof. Pap. 600-B, 119-22(1968).

Cesium was concentrated from solutions of rock samples by ion exchange onto ammonium molybdophosphate (AMP). Either x-ray fluorescence or atomic absorption spectrophotometry was used for the determination. Standard reference samples containing cesium in the range from about 1 to 10 ppM were analyzed and show good agreement with published results. The sensitivity for both methods is about 0.3 ppM on a 2-g sample. (auth)

27550 ATOMIC ABSORPTION DETERMINATION OF TELLURIUM. Nakagawa, H. M.; Thompson, C. E. U. S., Geol. Surv., Prof. Pap. 600-B, 123-5(1968).

Tellurium in soils and rocks was solubilized by treatment of the sample with hydrobromic acid–bromine mixture, selectively extracted into methyl isobutyl ketone, and measured by atomic absorption spectrophotometry applied to the separated ketone. As little as 0.1 ppM of tellurium could be detected, and amounts of 0.2 ppM or more could be measured with an accuracy comparable to that for an existing catalytic procedure. (auth)

27551 FALLOUT ANALYSIS OF ATMOSPHERIC WATER PRECIPITATIONS. PART II. DETERMINATION OF ^{144}Ce, ^{137}Cs, $^{89,90}Sr$, AND ^{140}Ba BY ION-EXCHANGE. Senegacnik, M.; Paljk, S.; Juznic, K. (Stefan Nuclear Inst., Ljubljana, Yugoslavia. Univ. of Ljubljana, Yugoslavia). Z. Anal. Chem., 233: 81-93 (1968).

A rapid ion-exchange method for the determination of ^{144}Ce, ^{137}Cs, ^{89}Sr, ^{90}Sr, and ^{140}Ba in 2 to 30 liter samples of atmospheric water precipitations is described. The samples, containing up to 300 mg of calcium, are sorbed on a specially shaped column filled with Dowex 50, X-8 or Dowex 50W, X-8. Radiocerium and radiocesium are stripped from the column with 0.6M ammonium glycolate/0.2M NaCl, pH 5, radiostrontium and radiobarium with 0.15M ammonium citrate, pH 7.5. The isolated radionuclides are counted on a low-background beta-counter: ^{144}Ce as CeO_2, ^{137}Cs as Cs-dipicrylaminate, $^{89}Sr/^{90}Sr$ as $SrCO_3$, ^{90}Y as Y_2O_3, and ^{140}Ba as $BaCO_3$. The mean chemical yields amount to 95% for cerium, 85% for cesium, 95% for strontium, 95% for yttrium, and 65% for barium. With parallel determinations at levels of a few picocuries, the deviations of the results from the respective mean values generally do not exceed ±5%. With a 30 l sample the limit of detection amounts to 0.005$\mu\mu$Ci/l for ^{144}Ce, 0.006 $\mu\mu$Ci/l for ^{137}Cs, 0.005$\mu\mu$Ci/l for ^{90}Sr, and 0.006$\mu\mu$Ci/l for ^{140}Ba. (auth)

27552 SPECTROSCOPIC DETERMINATION OF METALS IN WATER FOR THE CANADIAN BOILING LIGHT WATER REACTOR. Montford, B. (Whiteshell Nuclear Research Establishment, Pinawa, Can.). Can. Spectrosc., 4-10(Jan. 1968).

From the XIII Colloquim Spectroscopicum Internationale, June 19-23, 1967, Ottawa.

A method was developed for the sequential determination of iron, copper, nickel, cobalt, and zirconium in CANDU-BLW reactor feedwater and similar high-purity waters. These metals are concentrated on ion-exchange resin-loaded filter papers and determined by x-ray fluorescence spectrography. The method was calibrated in the range from 0 to 50 μg/l for the five metals. The effects of number of filtrations, flow rates, pH, and other cations were investigated and are reported. A batch of ten samples can be analyzed for five cations in two hours. The main advantages of the method are its simplicity, speed, and ease of recalibration with permanent standard disks. Suggestions are made for the automation of the concentration procedure. Comparisons are made between, pre-concentration techniques for metals by solvent extraction and ion-exchange resin-loaded filter papers, and their measurement by x-ray fluorescence spectrography and atomic absorption spectroscopy. Pre-concentration by ion exchange-loaded filter papers and subsequent measurement of the metals by x-ray fluorescence spectrography appears superior for feedwater analysis. (auth) (Canada)

27553 CHEMICAL AND RADIOCHEMICAL SEPARATION OF STRONTIUM AND YTTRIUM. Kar, K. R.; Singh, G.; Jain, S. C. (Univ. of Delhi). Mikrochim. Acta, No. 3, 614-18(May 1968).

A procedure is presented for the chemical and radiochemical separation of strontium and yttrium in mixtures which is based on the selective carrying of strontium by ignited barium sulfate leaving yttrium in the solution phase; the carried strontium is recovered by leaching with aqueous hydrochloric acid solution. In order to make strontium radiochemically free from yttrium activity, an initial isotopic dilution of the latter with ≥1 mg of inactive yttrium is an essential requirement. The method is applicable to chemical analysis of mixtures involving 1 to 3 mg of strontium and 1 to 16 mg of yttrium, both components being determined complexometrically after separation. (auth)

27554 4,4-ACETALIDINE-BIS-(3-METHYL ISOXAZOLONE-5) AS A NEW COLORIMETRIC REAGENT FOR THE DETERMINATION OF PALLADIUM AND URANIUM. Hashmi, M. H.; Rashid, Abdur; Ali, Shaukat; Ehsan, A. (Pakistan Council of Scientific and Industrial Research, Lahore). Mikrochim. Acta, No. 3, 608-13(May 1968).

Palladium and uranium react with 4,4-acetalidine-bis-(3-methyl-isoxazolone-5) in acid medium to give yellow color having a visual limit of identification at 2 and 15 μg per ml. This color reaction provides the basis of a new method for the colorimetric determination of palladium and uranium. Copper also gives a yellow color but it cannot be determined with this color reaction because the color intensity is not stable. The maximum tolerable limit of various ions is given. (auth)

27555 TITRIMETRIC MICRODETERMINATION OF LANTHANUM. Pandey, J. D.; Saxena, O. C. (Univ. of Allahabad, India). Mikrochim. Acta, No. 3, 636-8(May 1968).

A method for titrimetric determination of lanthanum is proposed by oxidizing lanthanum rhodizonate with ceric sulfate directly. A violet colored complex is precipitated when the solution containing sodium rhodizonate and lanthanum nitrate is boiled. By analysis it appears that with one lanthanum three rhodizonates are attached. It was observed that Na^+, K^+, and Zr^{4+} do not interfere but Ag^+, Cs^+, $Tl^{+,}$ Be^{2+}, Ca^{2+}, Sr^{2+}, Ba^{2+}, Zn^{2+}, Mg^{2+}, Hg^{2+}, Cu^{2+}, Sn^{2+}, Pd^{2+}, Bi^{3+}, Au^{3+}, Sb^{3+}, Al^{3+}, Rh^{3+}, Ru^{3+}, Ir^{3+}, Th^{4+}, Te^{4+}, Pt^{4+}, Se^{6+}, Cr^{6+}, W^{6+}, and U^{6+} do. (auth)

27556 DETERMINATION OF TRACE COMPONENT DISTRIBUTION IN ILLICIT SPIRITS BY NEUTRON ACTIVATION ANALYSIS (NAA), ATOMIC ABSORPTION (AA), AND GAS–LIQUID CHROMATOGRAPHY (GLC). Hoffman, C. M.; Brunelle, R. L.; Pro, M. J.; Martin, G. E. (Internal Revenue Service, Washington, D. C.). J. Ass. Offic. Anal. Chem., 51: 580-6(May 1968).

Trace inorganic constituents of illicit spirits were measured by neutron activation analysis and atomic absorption; organic constituents were determined by gas-liquid chromatography. These identifying components were evaluated statistically, and the data were applied to actual case work. Results also show that the use of multiple techniques increased the probability of matching two or more samples in determining a common source. (auth)

27557 ON THE IDENTIFICATION OF HYDROXAMIC ACIDS FORMED BY NITRIC ACID DEGRADATION OF KEROSENE AND i-DODECANE. Ohwada, Ken (Japan Atomic Energy Research Inst., Ibaraki). J. Nucl. Sci. Technol. (Tokyo), 5: 163-7(Apr. 1968).

Identification of hydroxamic acids in chemically degraded kerosene and iso-dodecane with nitric acid was carried out by ferric chloride test to characterize these acids, infrared spectroscopy, visible ray absorption spectroscopy, and extraction of fission products and zirconium nitrate. It is concluded from the above analytical results that small amounts of hydroxamic acids exist in both the degraded diluents. Their presence was also evidenced from an examination of the chemical behavior of long chain alkyl hydroxamic acids such as stearyl hydroxamic acid. It is furthermore suggested that some of the precursors to the hydroxamic acid are olefins originally contained and/or formed by radiolysis of paraffins, naphthenes and aromatics in the diluent. With the use of 2-octene, the process of formation of hydroxamic acid from olefins was estimated and is discussed on the basis of the results obtained. (auth)

27558 SOME RECENT APPLICATIONS OF NEUTRON ACTIVATION ANALYSIS STUDIED BY THE SECTION OF RADIOELEMENT APPLICATION OF THE C.E.A. (S.A.R) AT GRENOBLE. Diebolt, J. Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.), Suppl. No. 69(Jan.-Feb. 1968). (In French).

Examples of applications of neutron activation analysis to determinations with chemical separations either of a single element or of several elements and to nondestructive determinations of several elements either by simple measurement of the decay or by γ spectrometry and reduction of the complex spectrum by means of computers. The nuclear reaction used, the operational techniques, and the advantages are given for the determination of U in Mg, of Dy in a double nitrate of La and Mg, and of Sb and Au in plastic materials. The analysis of Cu for Na, P, Cr, Ni, Co, Zn, Ga, Ag, Sn, Sb, and Mn is also described. (J.S.R.)

27559 PRECIPITATION AND HYDROLYSIS OF THORIUM IN AQUEOUS SOLUTION. V. STUDIES OF THE SYSTEM: THORIUM NITRATE–AMMONIUM OXALATE. Bilinski, H.;

Ingri, N. (Inst. Ruder Boskovic, Zagreb. Royal Inst. of Tech., Stockholm). Croat. Chem. Acta, 39: 235-43(1967).

The precipitation of thorium from aqueous solution of thorium nitrate (1.25 mM) and ammonium oxalate (2.5 to 80 mM) was investigated at pH from 1 to 10. The following precipitates were identified with the brutto formula: $Th(OH)_4$ and $Th(C_2O_4)_2 \times 6\ H_2O$ (by means of chemical analyses). The soluble thorium oxalato complex is formed between these two precipitates and contains 4 oxalate bound to thorium, with the simplest formula $[Th(C_2O_4)_4^{4-}]$ (as determined by coulometric titration). Using log $K_0 = 34.8$ for the dissolution constant of thorium hydroxide in ammonium oxalate β_4 for thorium oxalate was obtained: 1.58×10^{24}. (auth)

27560 DETERMINATION OF VANADIUM IN SODIUM CHLORIDE BASIS WITH NEUTRON ACTIVATION ANALYSIS. Turkstra, J.; Toerien, P. V. S.; de Wet, W. J. (Afdeling Chemie, Pelindaba, S. Afr.). J. S. Afr. Chem. Inst., 20: 200-3(Oct. 1967). (In Afrikaans).

A carrier-free ion-exchange method was developed for selective quantitative separation of V from NaCl containing several transition elements in low concentration. Synthetic mixtures of 100 μg Cr, Co, Ni, Mn, W, Mo, Pt, and Hg and 5 μg V were adsorbed on a column of AG 1-X8 (200-400 mesh) in the oxalate form from a 0.5M HCl-0.5M oxalic acid solution; all but Mo(VI), W(VI), Pt(IV), Hg(II), and V(V) were washed through with the same solution. Vanadium was selectively eluted with 1.5M HCl-0.5M oxalic acid-0.007M H_2O_2. This procedure was applied to samples that were sealed and irradiated at 1.3×10^{13} n/cm^2 sec for 2 min and analyzed within 3 min after irradiation with a NaI crystal and 400-channel pulse height analyzer. The γ spectrum shows slight contamination with Al and possibly Cl, but the region around the 1.44-MeV peak of ^{52}V is free. Quantitative analysis with accuracy of 6% at the 5-μg level can be carried out by this method. (BBB)

27561 A METHOD FOR THE DETERMINATION OF THE RADIOACTIVE ISOTOPES ^{60}Co, ^{54}Mn, AND ^{65}Zn IN SEA WATER. Schmitt, Dieter E. Deut. Hydrogr. Z., 19: 28-38(1966). (In German).

A method for the analysis of ^{60}Co, ^{54}Mn, and ^{65}Zn in seawater and (with modifications) water of lower ion concentrations was developed for the Deutsche Hydrographische Institut, Hamburg. No ion-exchange resins are used. The final separation of the isotopes is carried out with an inactive carrier technique, in which Co is precipitated as $Cs_3Co(NO_2)_6$, Mn as MnO_2, and Zn as $Zn_2P_2O_7$. The runs were usually carried out on 10-l samples with 100 mg inactive carrier added. Gravimetric analysis and radioactive yield analysis for each element were shown to be approximately the same: for Co, 60%; for Mn, 80%. The derivation between gravimetric yield and radioactive yield was 2 to 3%. The efficiency of the method for 100 l of artificial seawater is greater than 0.2 pCi/l for each isotope. (BBB)

27562 RADIOMETRIC INVESTIGATIONS ON THERMAL EXPANSION AND TRANSITIONS IN POLYMERS. Klason, Carl; Kubat, Josef; de Ruvo, Alf (Royal Inst. of Tech., Stockholm). Rheol. Acta, 6: 390-6(Oct. 1967).

Theoretical and practical aspects are discussed of the use of β radiation for studying transitions in solid substances and in particular glass transitions in polymers. Also presented is a radiometric method based on measurements of the transmission of β rays through the sample at different temperatures; the transmitted intensity is determined by the dimensions and specific weight of the sample. Plots of this intensity against temperature yielded curves that show a change in slope at the transition temperature. Such plots exhibit a close similarity to those obtained dilatometrically. In both cases, the change in slope is associated with a discontinuity in the value of the coefficient of thermal expansion. The conditions for optimum sensitivity and accuracy are analyzed and used as a basis for improvement of this radiometric technique. The accuracy and resolving power of the method are illustrated with examples of transitions in a number of polymeric substances. It is shown that the coefficient of thermal expansion of the sample can be calculated from the slope of the transmission-temperature plots. (BBB)

27563 ATOMIC ABSORPTION ANALYSES FOR Ca, Li, Mg, K, Rb, AND Sr AT TWO ATLANTIC OCEAN STATIONS. Fabricand, B. P.; Imbimbo, E. S.; Brey, M. E. (Columbia Univ., Dobbs Ferry, N. Y.). Deep-Sea Res., 14: 785-9(Dec. 1967).

Measurements of the concentrations of the elements Ca, Li, Mg, K, Rb, and Sr were made for 2 Atlantic Ocean Stations, A, 18°59′N, 22°30.5′W and B 10°56′N, 49°30′W. Salinity and temperature were also measured. There were small variations in the ratios of the concentrations of these elements to chlorinity. The near-surface waters at A, off the African coast just north of the Cape Verde Islands, have higher element-chlorinity ratios than the deeper waters for Ca, Li, Mg, K, and Sr. At B, about 500 miles east of Trinidad, the Sub-Antarctic intermediate water and the Antarctic bottom water have slightly lower Mg-chlorinity ratios than the North Atlantic waters. The Li-chlorinity ratios for the waters at B are higher than those for Station A except for the near-surface sample at A which had the highest ratio measured. At B, the Li-chlorinity ratio tends to decrease with depth, and at A it is greatest for the Mediterranean water, except for the near-surface point. (BBB)

27564 ALKALINE EARTH PHOSPHATE AS CARRIER FOR THE DETERMINATION OF TRACE ELEMENTS IN SEAWATER. Doshi, G. R. (Bhabha Atomic Research Center, Trombay, India). Indian J. Chem., 5: 580-1(Nov. 1967).

A method is described for the determination of Co, Zn, and U in seawater involving their coprecipitation with alkaline earth phosphate. The individual separation of the elements is achieved by the use of both cation (Dowex-50) and anion (Dowex-1) exchangers. Co and Zn fractions are subjected to a thermal neutron flux in the swimming pool reactor, "Apsara" and quantitatively determined by γ spectroscopy. Uranium is determined by fluorimetry. (auth)

27565 USE OF PAPER CHROMATOGRAPHY AND COMPUTERS IN NEUTRON ACTIVATION ANALYSIS: APPLICATION TO QUANTITATIVE ANALYSIS OF La, Sm, Dy, Eu, IN LAVAS OF THE CHAINE DES PUYS. Coulomb, R.; Coquema, C.; Goldsztein, M.; Schiltz, J. C. (CEA, Fontenay-aux-Roses, France). Bull. Soc. Fr. Miner. Crist., 91: 75-84(Jan.-Mar. 1968). (In French).

A method of neutron activation analysis for four rare earths, lanthanum, samarium, dysprosium, and europium is presented. The complex gamma spectrum of the rare earths is resolved by the least squares method with the help of a computer. A preliminary separation of the alkaline elements is obtained by precipitation of the rare earths by iron hydroxide, followed by partition paper chromatography. This method was applied to a continous petrographic series of lava from the Chaîne des Puys. (auth)

27566 ION-EXCHANGE PRECIPITATION OF RHENIUM FROM ALKALI SOLUTIONS. Lebedev, K. B.; Ageev, S. A. Izv. Akad. Nauk Kaz. SSR, Ser. Khim., No. 2, 5-11(1967). (In Russian).

The effect of various factors on the capacity of AV-17 anion-exchange resin for the separation of rhenium was studied to determine the conditions for eluting rhenium from the saturated resin. The resin grain size was constant (0.5 to 0.8 mm) as was the degree of crosslinking. The effect of alkalinity on the absorptive capacity of AV-17 was studied by preparing synthetic solutions containing 2 mg of Re/l in the form of potassium perrhenate, and 0, 40, 80, and 160 g/l of caustic soda. One g of air-dried AV-17 in the OH form was used. The solution was passed through the column at a rate of 100 ml/hr, and samples were taken every 2 hr. The beginning of "breakthrough" was taken at the moment when more than 0.2 mg/l of Re began to show up in the filtrate. The results show a considerable reduction in the absorptive capacity of the resin with respect to Re as alkalinity increased due to the increase in the competing absorptive capacity of hydroxyl ions. Analogous tests for the effect of the type of charge (OH^-, SO_4^{2-}, and Cl^-) showed that this factor makes no appreciable contribution under dynamic conditions. Experiments were also conducted to determine the optimum specific load, i.e., the rate at which a certain quantity of solution is passed through 1 g of air-dried resin in a unit of time. The results showed a considerable reduction in the dynamic exchange capacity (an important factor from the industrial standpoint) with an increase in the unit load, although the total dynamic exchange capacity remained practically unaffected. Thus extremely high specific loads may be used for extracting Re from lean solutions with the use of AV-17 resin in some cases. The optimum unit load in industrial practice is taken as no more than 10 to 20 ml/hr through 1 g of resin. An increase in the temperature of the process from 20 to 60°C reduces the dynamic exchange capacity from 28 to 16%, and the total dynamic exchange capacity from 34.5 to 20.2%. The presence of MoO_4^{2-} and SO_4^{2-} anions in alkali solutions causes a sharp drop in the Re absorbing capacity of AV-17 anion-exchange resin. Almost no absorption of Mo by the resin is observed in this case. Excellent elutriation of Re from AV-17 resin is achieved by using a 2n solution of sulfuric acid at 80°C and a unit load of 12.5 ml/hr. (ATD)

27567 PAPER ELECTROPHORESIS OF METAL IONS IN ACETATE BUFFERS. Mazzei, M.; Lederer, M. (CNR Instituto di Chimica Generale ed Inorganica, Rome). Anal. Lett. 1: No. 1, 67-70(Oct. 1967).

Paper electrophoresis of the following metal ions in acetate buffers is described: Ag(I), Tl(I), Be(II), Mg(II), Ca(II), Sr(II), Ba(II), Bi(III), Cd(II), Pb(II), Hg(II), Cu(II), Co(II), Ni(II), Mn(II), Zn(II),

Al(III), Sc(III), Y(III), La(III), Ce(III), Fe(III), $Co(NH_3)_6^{3+}$, $Co(en)_3^{3+}$, Zr(IV), and ReO_4^-. Results are given for the mobility of all 26 ions in 0.1N, 0.5N, and 1.0N acetic acid-sodium acetate buffers. Values obtained from the high-voltage electrophoresis technique are compared to Rf values on Amberlite resin paper. Thallium and the Co(III) complexes show the highest mobility, followed by the divalent ions which are not complexed. The trivalent ions examined and Zr(IV) were all near the isoelectric point although some moved quite rapidly in dilute acetate, e.g., La(III) and Ce(III). Comparison of this series with results in several other electrolytes, in which numerous metals were electrophorized, revealed analogies with 0.5M sulfate except that Zn(II), Cd(II), and Cu(II) were not slowed down in sulfate. Comparison of the electrophoretic data with ion exchange data on a carboxylic resin showed that metal ions which move anionically in paper electrophoresis are also strongly adsorbed on the resin. This suggests that one of the functions of the carboxylic resin is to compete for complexation with the acetate ions in solutions. It thus is impossible, from ion exchange data lone to distinguish between a fast moving cation such as $Co(NH_3)_6^{3+}$ and an anionic complex such as Pb(II). (BBB)

27568 APPLICATION OF NEUTRON CAPTURE GAMMA SPECTROMETRY FOR STUDY OF LIGNITE STRATA IN BORE HOLES (PART I). Eife, Karl Heinz (Inst. for Petroleum Chemistry and Gas Industry, Moscow). Z. Angew. Geol., 12: 489-96 (1966). (In German).

In order to measure the wide variations in coal composition found in various strata, the spectral composition of γ capture irradiation produced is very valuable. The γ capture irradiation from H is characterized by a 2.23-MeV line. The other elements that are found in coal produce lines that range up to 10 MeV. The most intense lines are in the energy range from 3 MeV upwards. Because of the composition of coal strata and adjacent areas the intensity of the γ capture irradiation in the range 3 to 10 MeV is markedly reduced for lignite strata and depends on their ash content. In the energy range from 1.6 to 2.5 MeV the H irradiation predominates and lignite strata produce an increased intensity. It is not possible to calculate the relation of the γ capture irradiation of the various energy ranges from chemical compositions. However, laboratory studies showed that when small probe lengths are used, improved correlations between their factors may be obtained. (BBB)

27569 AMPEROMETRY WITH TWO POLARIZABLE ELECTRODES. CHELOMETRIC DETERMINATION OF RARE EARTHS. Vydra, Frantisek; Horacek, Jan (Heyrovskii Polarographic Inst., Prague). Anal. Lett., 1: No. 2, 31-7(Nov. 1967).

A method of determining rare earths by chelometric ethylenaminetetraacetate (EDTA) titration with biamperometric end-point indication using 2 stationary Pt electrodes was studied. EDTA and related compounds give anodic waves on a Pt electrode in the pH range 0.0 to 10.0. When EDTA is bound in metal chelates no electro-oxidation occurs. If a voltage of 0.4 to 1.1 V is applied to 2 electrodes, only the residual current due to supporting electrolyte registers up to the equivalence point. After the equivalence point the current increases abruptly. The convenient pH range for the determination cf La is 5.0 to 8.0; for Y, 3.5 to 8.0; and for Yb, 3.0 to 8.0. Rare earths were determined in the presence of Fe and Th. Iron and Th can be titrated at pH 1.5 to 2.0 and rare earths of the La group can be determined by successive titration at pH 5.0. Large amounts of rare earths of the Y group interfere with the determination of Fe and Th. The procedure is as follows. To a known amount of a 0.01M lanthanide solution, 4 ml of buffer solution is added and water is added to 100 ml. After pH adjustment, a voltage of 0.9 V is applied to the electrodes and the solution is stirred. Stabilization of the current occurs after 5 min. The sensitivity of the galvanometer is adjusted to 1×10^{-7} A. After each addition of titrant there must be a wait of 15 sec for stabilization of the current. A tangent is drawn to the titration curve at its maximum slope past the equivalence point, and the linear portion of the titration curve preceding the equivalence point is extrapolated. The end point is calculated from the intersection of these 2 lines. (BBB)

27570 THE SIMULTANEOUS DETERMINATION OF OSMIUM, RUTHENIUM, IRIDIUM, AND GOLD IN PLATINUM BY NEUTRON ACTIVATION ANALYSIS. Gijbels, R.; Hoste, J. (Ghent Univ.). Anal. Chim. Acta, 41: 419-29(June 1968).

Osmium, ruthenium, iridium, and gold can be determined simultaneously in 100-mg platinum samples after irradiation for 11 days at a thermal neutron flux of 4×10^{11} n·cm^{-2}·sec^{-1}. An addition method of analysis is used; samples are dissolved in small sealed silica tubes before activation. After irradiation, Os and Ru are distilled from sulfuric acid–sodium bromate, Ru being determined by counting the 498-keV peak of ^{103}Ru; Os is determined after a second distillation. Gold is extracted with ethyl acetate from the residue of the first distillation; the ratio ^{198}Au/^{199}Au is a direct measure for the gold content, with appropriate correction for the second-order reaction ^{196}Pt(n,γ)^{197}Pt → ^{197}Au(n,γ)^{198}Au. Ir is determined in the residual aqueous phase using the 317-keV peak of ^{192}Ir; a correction for the platinum activity (^{191}Pt) is made. The lower limit of determination is ca 0.5 ppM for ruthenium, ca 0.2 ppM for osmium, ca 0.1 ppM for gold and ca 0.1 ppM for iridium. After a separation of Pt from Ir, the sensitivity for Ir can easily be improved to <10 ppB. (auth)

27571 DETERMINATION OF IMPURITIES IN SINGLE CRYSTALS OF MAGNESIUM OXIDE BY NEUTRON ACTIVATION ANALYSIS. Lee, Hee Myong (London Univ.). Anal. Chim. Acta, 41: 431-40(June 1968).

The determination of some trace impurities in single-crystal magnesium oxide is described. Radiochemical separations of iron, cobalt, scandium, manganese, and chromium by ion exchange and solvent extraction are applied in conjunction with γ-spectrometry. The impurities that give rise to long-lived γ-emitting isotopes are considered. (auth)

27572 X-RAY DETERMINATION OF TRACES OF HAFNIUM IN ZIRCONIUM METAL OR TRACES OF ZIRCONIUM IN HAFNIUM METAL AFTER SEPARATION BY ION EXCHANGE. Luke, C. L. (Bell Telephone Labs., Inc., Murray Hill, N. J.). Anal. Chim. Acta, 41: 453-8(June 1968).

A method is proposed for the determination of traces of hafnium in zirconium metal or zirconium in hafnium metal. The trace metals are first separated from the matrix metals on an ion exchange column and then determined by x-ray analysis. (auth)

27573 EMISSION INTENSITY OF CESIUM IN FLAMES OF VARIOUS GAS COMPOSITIONS. Jadamec, J. Richard; Andersen, Neil R. (Research and Development Dept., Washington, D. C.). Anal. Chim. Acta, 41: 459-65(June 1968).

The emission intensity of cesium at 852.1 nm was studied in hydrogen flames burning with various mixtures of oxygen and nitrogen. A significant maximum was observed in the relative emission intensity of cesium at an oxygen to nitrogen ratio of 3 : 2 in the aspirating gas. The effect of Rb^+, K^+, Li^+, Na^+, and NH_4^+ ions on cesium emission is much less pronounced in this optimum flame than in a pure oxy–hydrogen flame. The optimum flame (60% oxygen) yields a significantly better calibration curve than can be obtained in either the normal air–hydrogen or oxy–hydrogen flame for 0 to 12 ppM cesium concentrations; the graph is linear over this concentration range. (auth)

27574 RAPID RADIOCHEMICAL SEPARATION OF SILVER BY AMALGAM EXCHANGE. Loepfe, E.; Monnier, D. (Univ. of Geneva). Anal. Chim. Acta, 41: 467-74(June 1968). (In French).

A rapid separation of silver on mercury is proposed in order to utilize shortlived isotopes for the determination of silver by activation. The conditions allowing quantitative reduction of silver were studied; a kinetic study showed that after 90 sec, 97% of silver could be transferred to the mercury. The spectrometric analysis of ^{110}Ag was also examined. Only metals with a redox potential greater than that of mercury form amalgams, and under the irradiation conditions these metals produce virtually no activity. (auth)

27575 RAPID RADIOCHEMICAL SEPARATIONS BY EXCHANGE WITH MERCURY. EXCHANGE OF GOLD AND PLATINUM AND SELECTIVE DETERMINATION BY THERMAL NEUTRON ACTIVATION. Monnier, D.; Loepfe, E. (Univ. of Geneva). Anal. Chim. Acta, 41: 475-81(June 1968). (In French).

A rapid extraction method of platinum and gold ions by means of a mercury drop is proposed. This is based on the different redox potentials of the various couples present and gives a separation from most other elements. The phenomenon is rapid and quantitative between defined concentration limits. The selectivity is good; silver interferes but this can be avoided. The sensitivity is excellent; with neutron activation in a flux of 7.7×10^{12} n·cm^{-1}·sec^{-1} for 2 h, the lower limit is about 5 ng/ml. (auth)

27576 THE DETERMINATION OF FREE ACIDITY IN CONCENTRATED AQUEOUS SOLUTIONS OF PLUTONIUM(IV). Damien, Nicole; Cauchetier, Philippe (CEN, Fontenay-aux-Roses, France). Anal. Chim. Acta, 41: 483-95(June 1968). (In French).

A method for the determination of free acidity in concentrated aqueous solutions of plutonium(IV) is described. The plutonium–EDTA complex is formed by addition of the calcium–EDTA complex and the neutralization titration with sodium hydroxide is followed potentiometrically, the equivalence point being determined by a graphical method. The relative standard deviation is 1%. Uranium and iron in small amounts do not interfere. The method is applicable to solutions which are ca 1 N in acid and which contain up to 200 g Pu/l. (auth)

27577 TITRIMETRIC MICRODETERMINATION OF RUTHENIUM(III) AND RHODIUM(III). Saxena, O. C. (Univ. of Allahabad, India). Microchem. J., 13: 130-4(Mar. 1968).

Titrimetic microdeterminations of ruthenium(III) and rhodium(III) with ceric sulfate are described. Oxidation results in the formation of ruthenium(IV) and rhodium(IV). The remaining ceric sulfate solution is titrated against a standard solution of ferrous ammonium sulfate using N-phenylanthranilic acid as indicator. Interference by cations was observed in both cases. Ranges in which ruthenium and rhodium were estimated vary from 0.3 to 16.6 mg/liter and from 0.19 to 11.7 mg/liter, respectively. (auth)

27578 RADIO-GAS-CHROMATOGRAPHIC INVESTIGATIONS OF FATTY ACID MIXTURES. Eberhagen, D.; Wittmann, B.; Seitz, W. (Univ., Munich). Z. Anal. Chem., 237: 17-25(Apr. 10, 1968). (In German).

A radio-gas-chromatographic device is described that was proved suitable for the analysis of substances of relatively small specific activity (down to about 50 nCi/mg). It was made from available equipment and operation is very simple. Application possibilities and limits of the method are discussed. (auth)

27579 STUDY OF THE INTERACTION OF ZIRCONIUM(IV) WITH PYROCATECHOL VIOLET. Luk'yanov, V. F.; Knyazeva, E. M. Zh. Anal. Khim., 23: 536-40(Apr. 1968). (In Russian).

A study was made of the interaction of zirconium(IV) with pyrocatechol violet in the presence of Complexon III. The colored compound was a three-component negatively charged complex. The ratio of zirconium to Complexon III and pyrocatechol violet was 3:3:2. (auth)

27580 AUFS-TYPE MEMBRANE FILTER AND DETERMINATION OF THE RADON-DECAY PRODUCT FILTERING EFFICIENCY OF SOME FIBROUS FILTERS. Toth, Arpad (Health Protection Service, Pecs, Hungary). Magy. Fiz. Foly., 15: 435-45(1967). (In Hungarian).

An aspiration method was developed to determine the concentration radon decay products in air. It involved the enrichment of the decay products by means of a membrane filter and measurement of their α activity. In view of the fact that a certain percentage of the decay products passes through the filter and thus escapes detection, the filtering efficiency was also taken into account. It was found that the AUFS-type filters fabricated before 1964 had a lower efficiency (η_F = 93.3%) than those prepared in 1966 (η_F = 98.9%). Experiment with RaA, RaB, and RaC radon decay products yielded identical results. On the other hand, the overall activity coefficient of these filters, $\nu_0 \eta_F k_S$ (whereby ν_0 is the air flow rate through the filter and k_S is the self absorption) was more unfavorable for the more recent products. The selective filtration efficiency measurements were carried out by using the natural radon products concentration of closed room, i.e., without any artificial enrichment. (TTT)

27581 X-RAY SPECTRAL FLUORESCENCE ANALYSIS OF SOLUTIONS OF RARE EARTH ELEMENTS OF THE CERIUM GROUP. Rekhkolainen, G. I.; Ivanova, L. I. Zavod. Lab., 34: 172-4(1968). (In Russian).

A method for the x-ray spectral fluorescence determination of La, Ce, Pr, and Nd in solutions containing rare earth elements of the cerium group was proposed. The sensitivity of the determination is 0.3 to 1.0 g/l for La, Ce, and Pr and 0.2 to 0.6 g/l for Nd. For rare earth concentrations of 5 to 200 g/l, the mean square deviation of the determination is $\ll$5%. The time expenditure for the analysis is 15 min. (tr-auth)

27582 PROCEEDINGS OF THE 2nd CONFERENCE ON PRACTICAL ASPECTS OF ACTIVATION ANALYSIS WITH CHARGED PARTICLES, LIEGE (BELGIUM), SEPTEMBER 21-22, 1967. Ebert, H. G. (ed.). Brussels, European Atomic Energy Community (EURATOM), 1968. 469p. $10.00. (In several languages). (EUR-3896; CONF-670947).

Separate abstracts were prepared for 19 of the 21 papers presented. The remaining papers were previously abstracted for NSA and appeared as abstracts 22: 1954 and 22: 1965. (D.H.M.)

For abstracts of individual papers see: 27583–27599, 29800, and 29926.

27583 RESPECTIVE DOMAINS FOR ACTIVATION ANALYSIS OF CHARGED PARTICLES, PHOTONS, AND NEUTRONS. Albert, Ph. (CNRS, Vitry, France). pp 3-14 of Proceedings of the 2nd Conference on Practical Aspects of Activation Analysis with Charged Particles, Liege (Belgium), September 21-22, 1967. Ebert, H. G. (ed.). Brussels, European Atomic Energy Community (EURATOM), 1968. (In French).

See EUR-3896; CONF-670947.

Developments in activation analysis since 1965 are reviewed. Problems of irradiation of samples and of standardization of doses are discussed in general terms. (D.H.M.)

27584 PRESENT STATUS OF THE ^{3}He-ACTIVATION ANALYSIS PROGRAM AT ORNL. Ricci, Enzo; Hahn, R. L. (Oak Ridge National Lab., Tenn.). pp 15-29 of Proceedings of the 2nd Conference on Practical Aspects of Activation Analysis with Charged Particles, Liege (Belgium), September 21-22, 1967. Ebert, H. G. (ed.). Brussels, European Atomic Energy Community (EURATOM), 1968.

See EUR-3896; CONF-670947.

Two stages of the program started in 1964 have been completed. During these studies it became clear that ^{3}He-activation analysis has great potential because of its very high sensitivity for light elements. A number of excitation functions were determined and a simple mathematical treatment of charged-particle activation analysis was developed. Unfortunately, a few problems of the method were uncovered as well, and work is being devoted to their solution. Analytical interference is particularly acute in ^{3}He-activation analysis. The relative amount of interference is proportional to the ratio of the average cross section, $\bar{\sigma}_i$, of the interferring reaction to that of the desired one, $\bar{\sigma}_s$. Thus, use was made of the previously determined excitation functions, to obtain simple mathematical expressions of $\bar{\sigma}$ vs E (bombarding energy) for all previously studied reactions. Therefore, optimum E values which correspond to minimum interference can now be easily obtained. Other important problems of ^{3}He-activation, and in general of charged-particle activation, are contamination-free sample handling and sample damage due to high-intensity charged-particle irradiation (50 to 100 μamp). Future work will be oriented toward the solution of these problems. Charged-particle activation analysis has such interesting possibilities that ORNL is considering the purchase of a small, high-intensity cyclotron to pursue research and development in this field. (auth)

27585 DETERMINATION OF NITROGEN AND BORON IN SILICONCARBIDE PROTON ACTIVATION ANALYSIS. Kuin, P. N. (Philips' Gloeilampenfabrieken, Eindhoven, Netherlands). pp 31-44 of Proceedings of the 2nd Conference on Practical Aspects of Activation Analysis with Charged Particles, Liege (Belgium), September 21-22, 1967. Ebert, H. G. (ed.). Brussels, European Atomic Energy Community (EURATOM), 1968.

See EUR-3896; CONF-670947.

A method is described for the quantitative determination of nitrogen and boron in silicon carbide by proton activation analysis using the reactions ^{14}N(p,α)^{11}C and ^{11}B(p,n)^{11}C. Boron is determined with 5-MeV protons and the sum of nitrogen and boron with 14-MeV protons. The comparison method is used. Proton fluxes are monitored with tantalum foils. A simple formula for the calculation of the results is given. For separation of the radioactivity induced in the silicon carbide matrix from the ^{11}C-radioactivity to be determined, an apparatus is described which separates carbon dioxide from most other acid-forming oxides. (auth)

27586 NONDESTRUCTIVE DETERMINATION OF CARBON IN SILICON BY THE REACTION ^{12}C(d,n)^{13}N. Schuster, E.; Wohlleben, K. (Siemens AG, Erlangen, Ger.). pp 45-63 of Proceedings of the 2nd Conference on Practical Aspects of Activation Analysis with Charged Particles, Liege (Belgium), September 21-22, 1967. Ebert, H. G. (ed.). Brussels, European Atomic Energy Community (EURATOM), 1968. (In German).

See EUR-3896; CONF-670947.

Carbon can be determined in silicon by the nuclear reaction ^{12}C(d,n)^{13}N. By irradiation of thick samples the induced ^{13}N activity in the product is proportional to the activation depth and cross section. The layer of activated material is removed after the activation measurements so that the sample can be irradiated again. Alternation of irradiation and layer removal allows determination of the distribution of carbon in the sample. (tr-auth)

27587 ANALYTICAL USE OF PROMPT NEUTRONS PRODUCED BY PULSES OF CHARGED PARTICLES. Peisach, Max. (Southern Universities Nuclear Inst., Faure, S. Africa). pp 65-102 of Proceedings of the 2nd Conference on Practical Aspects of Activation Analysis with Charged Particles, Liege (Belgium), September 21-22, 1967. Ebert, H. G. (ed.). Brussels, European Atomic Energy Community (EURATOM), 1968.

See EUR-3896; CONF-670947.

Methods are described for the determination of deuterium, carbon, nitrogen, and oxygen in microgram quantities in gases using 3-MeV deuterons. The relative standard deviation of the analytical results are between 3 and 4%. Sensitivities are below a microgram of the corresponding element. With protons, the Q-values of the (p,n) reactions on the abundant isotopes of carbon, nitrogen, and oxygen are so low that a 5-MeV proton beam does not generate any neutrons from them. On the other hand the heavier isotopes

undergo (p,n) reactions thus enabling their isotopic concentration to be determined. Similarly the time-of-flight spectrometry of neutrons from the reactions Ca(p,n)Sc on the various calcium isotopes was used as a means of isotopic determination of calcium-43 and -48. Possible extension of the technique to other analyses is discussed. (auth)

27588 ACTIVATION ANALYSIS DETERMINATION OF ALUMINUM WITH THE REACTION $^{27}Al(d,p)^{28}Al$ FOR DEUTERONS AT 0.6 TO 3.2 MeV. Schuster, E.; Wohlleben, K. (Siemens AG, Erlangen, Ger.). pp 103-18 of Proceedings of the 2nd Conference on Practical Aspects of Activation Analysis with Charged Particles, Liege (Belgium), September 21–22, 1967. Ebert, H. G. (ed.). Brussels, European Atomic Energy Community (EURATOM), 1968. (In German).

See EUR-3896; CONF-670947.

The reaction $^{27}Al(d,p)^{28}Al$ is suitable for the activation determination of aluminum. In thick samples the ^{28}Al activity in the product is proportional to the activation depth and cross section. These values were determined by use of aluminum metal as a standard for 16 discrete deuteron energies between 0.6 and 3.2 MeV. For a deuteron energy of 3.2 MeV the detection limit for this reaction is 1.5×10^{-10} g of Al. (tr-auth)

27589 APPLICATION OF NUCLEAR ISOMERISM FOR NONDESTRUCTIVE DETERMINATION OF CERTAIN ELEMENTS BY ACTIVATION WITH PHOTONS AT 4 TO 8 MeV. Engelmann, Ch.; Jerome, D. Y. (CEN, Saclay, France). pp 119-45 of Proceedings of the 2nd Conference on Practical Aspects of Activation Analysis with Charged Particles, Liege (Belgium), September 21–22, 1967. Ebert, H. G. (ed.). Brussels, European Atomic Energy Community (EURATOM), 1968. (In French).

See EUR-3896; CONF-670947.

The braking gamma radiation of electrons produced by a small linear accelerator was used to study the possibilities of nondestructive analyses afforded by the isomeric reactions (γ,γ'). Experience shows that numerous elements of an atomic number higher than 31 can thus be assayed by using gamma spectrometry for counting. This type of nuclear reaction has the advantage of giving active isotopes whose gamma spectra are particularly simple so that interference risks are rare. The influence of certain parameters on the specific activities induced was studied. Activation curves versus energy of incident electrons are given in respect of various elements (Sr, Y, Cd, In, etc.). With the relatively simple equipment employed and an average electron beam intensity of 10^{-4} A, assays can be done on quantities of a few micrograms for isotopes with periods greater than one second. (auth)

27590 USE OF THE NAVAL RESEARCH LABORATORY 60-MeV LINAC FOR PHOTON ACTIVATION ANALYSIS WITH PARTICULAR REFERENCE TO THE DETERMINATION OF FLUORINE IN SEA WATER. Wilkniss, P.; Linnenboom, V. J. (Naval Research Lab., Washington, D. C.). pp 147-60 of Proceedings of the 2nd Conference on Practical Aspects of Activation Analysis with Charged Particles, Liege (Belgium), September 21–22, 1967. Ebert, H. G. (ed.). Brussels, European Atomic Energy Community (EURATOM), 1968.

See EUR-3896; CONF-670947.

Use of the NRL 60-MeV Linac for photon activation analysis is outlined. The converter and the bremsstrahlung intensity distribution are described, as are the pneumatic transfer system and sample rotator used in the irradiations. The determination of fluorine in sea water and the problems encountered, such as interfering reactions, sample preparation, etc., are discussed and some results obtained with the method are given. (auth)

27591 ANALYSIS OF THE RARE EARTHS BY IRRADIATION WITH PHOTONS AT HIGH ENERGIES. Owlya, A.; Abdeyazdan, R.; Albert, Ph. (CNRS, Vitry, France). pp 161-94 of Proceedings of the 2nd Conference on Practical Aspects of Activation Analysis with Charged Particles, Liege (Belgium), September 21–22, 1967. Ebert, H. G. (ed.). Brussels, European Atomic Energy Community (EURATOM), 1968. (In French).

See EUR-3896; CONF-670947.

Samples of the rare earth metals and yttrium and their oxides were irradiated by γ photons at maximum energies in the range 25 to 45 MeV. The radioisotopes produced were identified and their radioactivity measured. Results of the measurements are considered from two points of view: the possibility of determining each element irradiated, and the eventual interference of the activity of radioisotopes produced by irradiation of the rare earth elements in the determination of carbon (by ^{11}C) and of oxygen (by ^{15}O). Thus it is possible to determine if chemical separation is necessary when determining rare earth impurities. It was shown that the irradiation by photons is a very sensitive method of determining the rare earth elements. (tr-auth)

27592 NONDESTRUCTIVE ACTIVATION ANALYSIS WITH PROTONS, DEUTERONS, AND GAMMA-PHOTONS. Meyers, P. (Instituut voor Kernphysisch Onderzoek, Amsterdam). pp 195-224 of Proceedings of the 2nd Conference on Practical Aspects of Activation Analysis with Charged Particles, Liege (Belgium), September 21–22, 1967. Ebert, H. G. (ed.). Brussels, European Atomic Energy Community (EURATOM), 1968.

See EUR-3896; CONF-670947.

Several methods of nondestructive activation analysis were developed. These methods, applied to various samples, refer to: determination of copper and silver content in ancient gold coins; determination of copper, gold and lead content in ancient silver coins; determination of Fe, Ni, Zn, As, Sn, Sb and Pb in ancient copper coins and bronze objects; determination of Fe, Ni and Co in iron meteorites; and determination of the weight ratio of nitrogen and fluorine in fossil bones and teeth. The gold and silver coins were irradiated in the external beam of the IKO cyclotron with 30-MeV protons and 26-MeV deuterons, respectively. Copper coins and bronze objects were irradiated with fast neutrons, while iron meteorites and fossil bones were activated with high energy photons, produced in the IKO linac. The gamma ray countrates of the various activities in the irradiated samples were determined by decay analysis, using a 3" × 3" NaI(Tl) crystal, connected to a single channel analyzer, or by gamma ray spectrum analysis, using a 8-cm^3 Ge(Li drifted) crystal, connected to a 400 or 1024 channel pulse height analyzer. (auth)

27593 DETERMINATION OF OXYGEN IN ZIRCONIUM, MOLYBDENUM, HAFNIUM, AND TUNGSTEN BY IRRADIATION WITH ^3He AND ^4He PARTICLES. Revel, G.; Albert, Ph. (CNRS, Vitry, France). pp 261-75 of Proceedings of the 2nd Conference on Practical Aspects of Activation Analysis with Charged Particles, Liege (Belgium), September 21–22, 1967. Ebert, H. G. (ed.). Brussels, European Atomic Energy Community (EURATOM), 1968. (In French).

See EUR-3896; CONF-670947.

After irradiation in a beam of ^3He ions of energies below 11 MeV, oxygen can be determined without chemical separation in Zr, Mo, Hf, and W. The limits of experimental sensitivity obtained (0.01×10^{-6} for Zr) were satisfactory for the study of these metals. The experimental conditions were chosen so that impurities did not affect the results. The values obtained were in good agreement with those obtained by other methods of analysis or by control. The determination of carbon can be considered as parallel with that of oxygen, but is is necessary to determine the effects of light elements that may be present as traces in the metal being analyzed. Upper limits for the concentration of carbon were established (for the purest samples this limit was of the order of several ppM). The possibility of determining the oxygen in zirconium by α particles was studied. The precision and the limit of the method are discussed. (tr-auth)

27594 DETERMINATION OF LOW OXYGEN CONTENT IN IRON, NICKEL, AND CHROME BY ACTIVATION WITH ALPHA PARTICLES. Barrandon, J. N.; Debrun, J. L.; Albert, Ph. (CNRS, Vitry, France). pp 277-91 of Proceedings of the 2nd Conference on Practical Aspects of Activation Analysis with Charged Particles, Liege (Belgium), September 21–22, 1967. Ebert, H. G. (ed.). Brussels, European Atomic Energy Community (EURATOM), 1968. (In French).

See EUR-3896; CONF-670947.

Preliminary results from the study of the determination of oxygen in Fe, Cr, and Ni by alpha particles are described. The irradiations were carried out in synchrocyclotron at the Centre d'Etudes Nucléaires at Lyon and in the cyclotron at the Centre d'Etudes Nucléaires at Saclay. The maximum energies of the particles supplied by the apparatus were 55 MeV and 45 MeV, respectively. The principle of the determination, the method used, the cause of error, and the practical results are considered. (tr-auth)

27595 SOME ASPECTS OF THE OXYGEN DETERMINATION BY THE $^{16}O(t,n)^{18}F$ REACTION. de Goeij, J. J. M.; Houtman, J. P. W. (Reactor Instituut, Delft, Netherland). pp 293-318 of Proceedings of the 2nd Conference on Practical Aspects of Activation Analysis with Charged Particles, Liege (Belgium), September 21–22, 1967. Ebert, H. G. (ed.). Brussels, European Atomic Energy Community (EURATOM), 1968.

See EUR-3896; CONF-670947.

Factors that can influence the accuracy and sensitivity of the oxygen determination by the $^{16}O(t,n)^{18}F$ reaction were investigated. For carrying out the reaction with tritium, an oxygen-containing sample must be brought into contact with a lithium-containing compound. Two types of contact are described, the homogeneous, where the lithium is present in the sample of which the oxygen content is required, and the heterogeneous, where the lithium-containing compound and oxygen containing compound are pulver-

ized and mixed or the samples are present in a simple geometric shape (disc or foil) and covered by a lithium-containing foil. The selection and preparation of standards are discussed and comparison is made with literature values. The accuracy obtained in the determination of oxygen in aluminum fluoride and reduced graphite oxide is discussed. (D.H.M.)

27596 DETERMINATION OF LOW QUANTITIES OF OXYGEN AND CARBON BY ACTIVATION WITH PHOTONS AND α PARTICLES. Engelmann, Ch.; Fritz, B.; Gosset, J.; Graeff, P.; Loeuillet, M. (CEN, Saclay, France). pp 319-50 of Proceedings of the 2nd Conference on Practical Aspects of Activation Analysis with Charged Particles, Liege (Belgium), September 21–22, 1967. Ebert, H. G. (ed.). Brussels, European Atomic Energy Community (EURATOM), 1968. (In French).

See EUR-3896; CONF-670947.

Results relating to the assaying of oxygen and carbon by activation with gamma photons and alpha particles are reported, including the chemical separation methods developed, the smallest assayable contents, and a study of the nuclear interference present. The assaying of oxygen in high-purity silicon by activation with alpha particles, and the assaying of carbon in nickel by irradiation in gamma photons are particularly stressed. The contents determined by these methods situated in the 10^{-6} to 10^{-5} mass range are compared with those obtained by mass spectrometry on the same materials. A number of examples are given to show the potentialities of nondestructive analysis of oxygen and carbon in ultrapure silicon by activation with alpha particles, with mass contents of 10^{-7} to 10^{-6}. (auth)

27597 TRACE OF THE EXCITATION FUNCTION OF THE REACTION $^{16}O(d,n)^{17}F$ UP TO 27 MeV AND DISCUSSION OF ITS UTILIZATION FOR OXYGEN DETERMINATION. Lacroix, Marie-Jose; Tran Minh Duc; Tousset, Jean (Univ., Lyon). pp 351-70 of Proceedings of the 2nd Conference on Practical Aspects of Activation Analysis with Charged Particles, Liege (Belgium), September 21–22, 1967. Ebert, H. G. (ed.). Brussels, European Atomic Energy Community (EURATOM), 1968. (In French).

See EUR-3896; CONF-670947.

For the purpose of analyzing oxygen, the reaction $^{16}O(d,n)^{17}F$ was studied to deuteron energy of 27 MeV. A synchrocyclotron with a semiautomatic target conveyor was used. The intensity of the beam on the samples, although weak, was sufficient (10^{12}d/cm sec). The standardization between the two irradiations was performed by comparison of the activities of 50-micron aluminum discs, placed in front of the sample at the maximum energy, from which the reaction $^{27}Al(d,p)^{28}Al$ was produced. The variations at the level of the sample of the energy of particles emitted by the accelerator were obtained by the inner position of a screen. This resulted in a distribution of energy, comparable to a Gaussian distribution, which was added to the natural dispersion of the beam. The importance of this phenomenon, which leads to a separation at low energy of the activation curve obtained and of the true excitation function, was experimentally estimated. The samples were discs of beryllium oxide of 50 to 200 microns obtained by roasting and with excellent mechanical properties. The curve was determined as a function of the energy of the mean effective cross section, the standardization of which was obtained by comparison with a reaction of known effective cross section such as $^{63}Cu(d,n)^{63}Zn$. A comparison of the theoretical sensitivity for the determination of oxygen by the two methods, formation of ^{17}F with deuterons and the formation of ^{18}F with α-particles, is outlined. By choosing experimental conditions that are ordinarily used, the ratio of the sensitivities was of the order of 3 in favor of the α-particles. The influence of the matrix on the parasitic reaction prohibited generalization. (tr-auth)

27598 EXAMINATION OF SURFACES BY SCANNING WITH CHARGED PARTICLES. Pierce, T. B. (Atomic Energy Research Establishment, Harwell, Eng.). pp 389-401 of Proceedings of the 2nd Conference on Practical Aspects of Activation Analysis with Charged Particles, Liege (Belgium), September 21-22, 1967. Ebert, H. G. (ed.). Brussels, European Atomic Energy Community (EURATOM), 1968.

See EUR-3896; CONF-670947.

Investigations were carried out to evaluate charged-particle scanning as a method for the micro-examination of surfaces. Finely collimated beams of particles were allowed to fall on the sample, and information about the composition of the samples was obtained from analysis of the particle or γ-ray spectra accumulated during the irradiation. By moving the position of the target relative to the beam, different parts of the sample surface can be examined and hence a knowledge of the change in composition of the sample over short distances can be built up. With the very simple target assemblies used for these feasibility studies, beams with effective diameters of not less than 100 μ were employed for both elemental and surface layer analysis. (auth)

27599 EQUIPMENT UTILIZED FOR IRRADIATION OF METALLURGICAL SAMPLES AT THE LINEAR ACCELERATOR AND CYCLOTRON AT SACLAY. Engelmann, Ch.; Graeff, P.; Re, C. (CEN, Saclay, France). pp 403-33 of Proceedings of the 2nd Conference on Practical Aspects of Activation Analysis with Charged Particles, Liege (Belgium), September 21–22, 1967. Ebert, H. G. (ed.). Brussels, European Atomic Energy Community (EURATOM), 1968. (In French).

See EUR-3896; CONF-670947.

The accelerators now fitted with irradiating equipment with a view to their use for activation analysis are: (a) The variable-energy linear accelerator with a range of about 15 to 45 MeV. The average intensity of the electron beam is some tens of μA. The specimens are despatched from the laboratory 200 m away in aluminium cartridges. (b) The fixed-energy cyclotron, used chiefly for activation by alpha particles. The beam intensity is several μA. By means of a remote-controlled probe with an aluminium window 50 μ thick, cartridges can be irradiated in the air outside. Positioning is by hand. The specimen is automatically recovered in the compressed-air circuit at the end of the irradiation. (c) The Phillips variable-energy cyclotron. A quadrupolar system is used to focus the beam on the specimen. The irradiation area can be defined by means of an assembly of remote-controlled lips. The specimens are irradiated under vacuum. Positioning and recovery are by hand. A compressed-air circuit is installed for the receipt and despatch of specimens. This cyclotron is mainly used for proton and ^{3}He irradiations. The energies are adjustable from a few MeV to 25 and 35 MeV respectively for the two particles. The beam intensity will be several μA. The last two cyclotrons are located 500 and 600 m from the laboratory. A very brief description of a new irradiation device for a rotating cyclotron designed for 24 specimens, with automatic loading and unloading is given. (auth)

27600 ACTIVATION ANALYSIS WITH DEUTERONS: THE TOTAL CROSS SECTION OF THE REACTION $^{27}Al(d,p)^{28}Al$ FROM 0.6 TO 3.2 MeV. Schuster, E.; Wohlleben, K. Int. J. Appl. Radiat. Isotop., 19: 471-4(May 1968). (In German).

The reaction $^{27}Al(d,p)^{28}Al$ is suitable for the determination of aluminium by activation analysis. In thick samples the induced ^{28}Al activity is proportional to the product of the activation depth D^* and the cross section σ^* averaged over D^*. The value of σ^*D^* was determined for 16 discrete deuteron energies between 0.6 and 3.2 MeV, using aluminium metal as standard. D^* and, consequently, σ^* were determined with the calculated range energy relation for deuterons in aluminium. Considerable deviations from the values stated in the reference literature resulted for the cross section $\bar{\sigma}$ averaged over the interval of adjacent energies. (auth) (UK)

27601 ULTRA-TRACE ANALYSIS OF BERYLLIUM BY GAS CHROMATOGRAPHY. Ross, W. D. (Monsanto Research Corp., Dayton, Ohio); Sievers, R. E. pp 272-82 of Proceedings of Sixth International Symposium on Gas Chromatography and Associated Techniques, Rome, 20–23 Sept. 1966. Littlewood, A. B. (ed.). London, Institute of Petroleum, 1967.

Amounts of beryllium as small as 4×10^{-13} g can be detected by electron-capture gas chromatography of beryllium(II) trifluoroacetylacetonate. Calibration curves were obtained over the range from 8×10^{-13} to 4×10^{-11} g of beryllium. A quantitative method for determining beryllium in aqueous solution by solvent-extraction, with subsequent gas-chromatographic determination, is described. Radioactive ^{7}Be was used to determine the distribution of beryllium between the organic and aqueous phases in the solvent-extraction step and to establish whether traces of beryllium were lost by adsorption. (UK) (auth)

27602 ANALYSIS OF PETROLEUM PRODUCTS BY ABSORPTION OF RADIOACTIVE RADIATIONS. 5. RADIOACTIVE ABSORPTION METHOD AND APPARATUS FOR THE CONTINUOUS ANALYSIS OF THE HETEROATOM CONTENT OF LIQUID PETROLEUM AND PETROCHEMICAL PRODUCTS. Balint, T. Acta Chim. Acad. Sci. Hung., 52: 243-9(1967).

The method described ensures density compensation by a mechanical principle when the changes of density are neither too great (not exceeding ±0.05 to 0.10 g per ml) nor negligibly small. If sudden great changes of density are anticipated, the regulating and measuring vessels must be connected in parallel. The apparatus used in the method has many advantages. It displays high sensitivity to changes of density. Further advantages are minimum sensitivity to the velocity of flow of the liquid to be analyzed and the possibility of eliminating the source of error arising from changes of the distance between source of radiation and detector. The apparatus is simple in design and is suitable for use in industry. (Hung. Tech. Abstr.)

27603 DISTRIBUTION OF TRACE ELEMENTS IN CHONDRITIC METEORITES. PART 1. GALLIUM, GERMANIUM, AND INDIUM. Fouche, K. F.; Smales, A. A. Chem. Geol., 2: 5-33(1967).

A rapid neutron activation technique was developed for simultaneous determination of Ga, Ge, and In in geological materials, and was employed to examine fractionation of these elements between ordinary, enstatite, and carbonaceous chondrites and to investigate the distribution of Ga and Ge between magnetic and nonmagnetic fractions of ordinary and enstatite chondrites. Ga and Ge contents of metal phases of different chondrite groups were compared. All three elements are fractionated among the different chondrite classes with depletion ratios in the order Ga < Ge < In. Ge, but not Ga, is enriched in bronzite relative to hypersthene chondrites. Results support previous suggestions that enstatite chondrites should be subdivided into two groups. Fractionation patterns of Ga and Ge between types I, II, and III carbonaceous chondrites are similar, but In is more strongly fractionated. (auth) (Geophys. Abstr.)

27604 DETERMINATION OF TRACE AMOUNTS OF SCANDIUM BY ATOMIC ABSORPTION SPECTROSCOPY. Chau, Yiu-kee (Chinese Univ. of Hong Kong). Talanta, 15: 421-4 (May 1968).

Optimum instrumental conditions were investigated for the determination of trace quantities of scandium by atomic absorption spectroscopy. Enhancement effects by organic solvents and by complex extractions were also studied. ^{46}Sc was used to establish the optimum extraction conditions. A sensitivity of 0.06 ppM of Sc was observed when using extraction into oxine–butanol and measurement of atomic absorption with an acetylene–nitrous oxide flame. (auth) (UK)

27605 DETERMINATION OF ZIRCONIUM IN ROCKS BY X-RAY FLUORESCENCE USING SCATTERED RADIATION TO CORRECT FOR MATRIX EFFECTS. Webber, G. R.; Vollrath, Jeanne D. (McGill Univ., Montreal). Can. Spectrosc., 12: No. 3, 3-7(May 1967).

Scattered W radiation from the x ray tube can be used to make absorption corrections in the determination of Zr in rocks. Theoretical calculations were made to determine the limitations of this method. A comparison of theoretical and observed intensities shows that some discrepancies still exist. For practical purposes the method is applicable to silicate rocks, but extension to carbonate rocks requires additional correction. (auth)

27606 DETERMINATION OF NICKEL AND IRON IN FERRITE MATERIALS BY ACTIVATION ANALYSIS. Kliment, V. (Inst. of Physics, Bratislava). Chem. Zvesti, 20: 682-5(1966). (In Slovak).

The sample, after irradiation for 80 hr in a neutron flux of $\approx 3 \times 10^{12}$ neutrons per sq cm per sec., was dissolved in concentrated HCl–concentrated HNO_3 (1:1), with repeated evaporation. The γ-ray activities of ^{59}Fe and of the ^{58}Co produced from ^{58}Ni were measured after their separation from a solution 8M in HCl on a column of Dowex 2-X8 anion-exchange resin (Cl- form) and elution of Co with 4M-HCl and Fe with 0.4M-HCl. The method is suitable for analyzing samples containing down to 10^{-6} g of Ni and of Fe. (Anal. Abstr. Vol. 15, Jan. 1968)

27607 DETERMINATION OF Sc AND Cs TRACES IN FIVE PREDAZZO GRANITES BY NEUTRON ACTIVATION ANALYSIS. Marchetti, Fulvia; Nucifora, Giuseppina (Univ., Bologna). Ric. Sci., 37: 963-6(Nov. 1967). (In Italian).

Analyses by neutron activation and γ multichannel spectroscopy of Predazzo granites were carried out. Quantitative data on the presence of scandium and cesium are given in the range of 3.0 to 8.5 ppM for cesium, and 0.3 to 2.3 ppM for scandium. Suggestions are made regarding the role of these elements on the basis of their amounts. (auth)

27608 NOTE ON THE DETERMINATION OF NIOBIUM IN STABILIZED STAINLESS STEELS. Mathur, P. K.; Venkateswarlu, Ch. (Bhabha Atomic Research Centre, Bombay). Indian J. Chem., 5: 521-2(Oct. 1967).

Niobium in stabilized stainless steels is concentrated taking advantage of the preferential insolubility of its hydrous oxide in dilute nitric acid solutions (pH $\simeq$ 1.0) and determined spectrophotometrically. (auth)

27609 REPLACEMENT SUBSTOICHIOMETRY AND ITS APPLICATION IN ACTIVATION ANALYSIS. Obrusnik, Ivan (Inst. of Nuclear Research, Rez, Czech.); Adamek, Arnold. Talanta, 15: 433-40(May 1968).

A method based on the substoichiometry principle was developed. Instead of substoichiometric amounts of chelating agent, substoichiometric amounts of an aqueous solution of a competing metal are used. Theoretical relationships were derived for this method of substoichiometric replacement. Possibilities for its application are discussed. (auth) (UK)

27610 THE MICROANALYTICAL ESTIMATION OF BORON IN STEEL USING THE $^{10}B(n,\alpha)^7Li$ REACTION. Loveridge, B. A.; McInnes, C. A. J. (Atomic Energy Research Establishment, Harwell, Eng.). Microsc. Cryst. Front, 16: 105-14(1967).

The distribution of boron can be accurately determined in steels at concentrations from about one ppM upwards using cellulose acetate as a solid state detector for the alpha particles. A piece of the plastic is placed in contact with a polished surface of the sample which is irradiated in a nuclear reactor with a total thermal neutron dose of 10^{13} n/cm^2. The plastic is then etched in 6N sodium hydroxide until the alpha tracks are large enough to be seen by the scattering of transmitted light under a microscope at linear magnifications of 450× or greater. The alpha tracks can be counted using the Image Analysing Computer ("Quantimet") Microscope to which a digital print-out was added using Harwell Type 2000 electronic equipment and an Addo-X printer to improve the speed of data handling. The precision of quantitative analyses on samples of standard steels is about ±10% when an area of 0.4 mm^2 is scanned for alpha tracks. Surface areas as small as 0.001 mm^2 can be analyzed for only a few picograms (10^{-12}g.) of boron, although the precision is necessarily severely limited in such cases. (auth) (UK)

27611 SAMPLE PREPARATION TECHNIQUES FOR SCINTILLATION COUNTING. Fox, B. W. (Christie Hospital, Manchester, Eng.). Lab. Pract., 17: 595-8(May 1968).

The main problem in liquid scintillation counting of tritium and ^{14}C is to achieve maximum counting efficiency of the sample available with as little pretreatment as possible. Recent methods improved the estimation of biopolymers and biomonomers in solution, as obtained from typical biochemical procedures such as trichloroacetic acid extraction, column chromatography with salt-laden buffers, and centrifugation with sucrose solutions. In particular, the use of glass-fiber discs and Triton X100 in scintillation counting is discussed and some recent observations with ambient temperature counting using the Triton X100 scintillant are described and compared with scintillants more usually employed. (auth) (UK)

27612 STUDY OF THE ASSOCIATION BETWEEN TRIBUTYL PHOSPHATE AND WATER. Roland, G.; Duyckaerts, G. (Institut de Chimie-Metallurgie, Liege). Spectrochim. Acta, Part A, 24: 529-49(May 1968). (In French).

The association between water (A) and tributyl phosphate (D) dissolved in an organic diluent (CCl_4 or CS_2) was studied. Determination of the extracted water in the organic phase and intensity measurements of the absorption bands of the free ν(OH) and bonded ν(—OH...) led to the following conclusions: In dilute solutions ([D] < 0.1 mole/l(CCl_4) and [D] < 0.07/mole/l(CS_2), the complexed species is DA with a stability constant of 0.15 ± 0.01 (CCl_4) and 0.120 ± 0.008(CS_2). For higher concentrations (0.1 < [D] < 0.7 mole/l(CCl_4) and 0.07 < [D] < 0.5 mole/l(CS_2) a dimer is formed with a dissociation constant $K_d = [DA]^2/[D_2A_2] = 0.2889 \pm 0.0026$ mole/l(CCl_4) and 0.1132 ± 0.0008 mole/l(CS_2). For concentrations 0.70 < [D] < 1.15 mole/l(CCl_4) and 0.5 < [D] < 1.0 mole/l (CS_2), it seems that higher complexes such as D_mA_m with m = 10 (CCl_4) and m = 4 (CS_2) are formed. The dissociation constants $K_3 = [D_2A_2]^m/[D_mA_m]$ are (7.40 ± 0.12)10^{-5} (mole/l)^4 in CCl_4 and 0.302 ± 0.005 mole/l in CS_2. (auth) (UK)

27613 SPECTROCHEMICAL DETERMINATION OF ISOTOPE RATIO OF OXYGEN BY MICROWAVE DISCHARGE METHOD. Kamada, Hitoshi; Oda, Shohei; Hori, Takeshi (Tokyo Univ.). Bunseki Kagaku, 17: 469-74(Apr. 1968). (In Japanese).

The isotope ratio of oxygen ($^{16}O/^{18}O$) in the form of carbon monoxide was determined by spectrometry with microwave discharge. The determination was done by the measurement of intensity ratio of CO^+ band ($B^2\Sigma - {}^2\Sigma$, 2445.8 Å) and its shifted isotope band. The stable CO^+ band with the highest intensity was obtained at a concentration of 2% (v/v) carbon monoxide in helium atmosphere. The analytical curve was prepared on the standard samples; isotope ratios were determined by mass spectrometry. The standard deviation of the result was about 2% for 35% of $C^{18}O$. The results were not affected by the coexisting nitrogen and hydrogen. (auth)

27614 SPECTROPHOTOMETRIC DETERMINATION AND EXTRACTION OF TANTALUM WITH METHYL VIOLET. Rutkowski, W.; Wasowicz, S. (Inst. of Nuclear Research, Warsaw). Chem. Anal. (Warsaw), 11: 971-8(1966). (In Polish).

The fluoride complex of Ta with methyl violet (C.I. Basic Violet 1), when extracted into benzene, exhibits absorption maximum at 540 nm and at 605 nm (the more intense). From 30 ml of a solu-

tion 0.2M to 0.3M in HF at pH 2.2 to 2.3 containing 6.6×10^{-5} g of methyl violet per ml, 80% of the Ta is extracted by shaking for 1 min with 10 ml of benzene. Small amounts of HCl and H_2SO_4 do not interfere, but HNO_2 induces co-extraction of the methyl violet. Mercury interferes, but Ca, Cu, Fe, K, Mg, Na, Ti, W, Zn, Zr, Sn (up to 5 mg per ml), As (up to 70 μg per ml) Al (up to 1.5 mg per ml), Mo (up to 3 mg per ml), Nb (up to 0.2 mg per ml) and Re (up to 5 μg per ml) do not. (Anal. Abstr. Vol. 15, Jan. 1968)

27615 MINOR ELEMENTS IN IRON ORES FROM THE WESTERN UNITED STATES. Radtke, Arthur Sears. Stanford, Calif., Stanford Univ., 1965. 426p.

Thesis.

Ores from 194 deposits were studied to determine the abundance and distribution characteristics of the minor elements in each type of deposit. The distribution and concentration of minor elements are discussed in relation to the composition of the genetically affiliated igneous rocks, ore genesis, source material, depositional environment, oxidation, and metamorphism. Abundance values and averages for individual and groups of deposits are compared with the value given in the literature for deposits of similar genesis in other geographical areas. Minor element abundances are examined to determine local or regional concentration levels of individual and associated elements. A method of rapid quantitative spectrochemical analysis for determining 27 minor elements over wide abundance ranges in iron ores was developed. Elements sought included As, Sb, Bi, Ba, Sr, Be, Nb, Ta, Cu, Ga, Ge, Sn, Pb, B, Mo, Ti, V, Zn, Cd, and Hg. All synthetic standards and samples were burned in a controlled CO_2 atmosphere with Pd added as an internal standard. Good precision was achieved for both volatile and involatile elements in ores containing iron oxides, carbonates, and silicates or various mixtures of these phases. Each of the 27 elements is discussed, and the abundance and distribution ranges in each type of deposit are presented and evaluated in the light of geochemical behavior. The relations of minor elements to types of deposits are discussed. Distributions and concentrations of minor elements in iron ores related to magmatic processes show trends similar to those for associated igneous rocks, thus emphasizing the relation between ore and igneous rock. Iron deposits related to sedimentary processes show wider variations in minor element content, reflecting differences in source material, depositional environment, oxidation, weathering, supergene enrichment, and regional metamorphism. The relations between composition of source rock and minor element abundance in laterite and leached sedimentary iron formation is discussed. The minor element content of leached sedimentary iron formation is shown to reflect strongly that of the banded sedimentary iron formation and shows these deposits formed by leaching of iron formation rather than as a sedimentary precipitate. The abundance of minor elements in banded sedimentary iron formations compared to sedimentary hematite-goethite-siderite and oolitic sedimentary hematite show a general decrease accompanying metamorphism. The concentration of Cu, Ge, Pb, and Mn, and a lesser degree As, Be, Sn, and Zn in central Arizona iron formations compared with those in Montana, Wyoming, and Colorado, is interpreted to mean that there have been larger regional abundances of those elements in crustal material of the southwestern United States as early as the Precambrian. (Diss. Abstr.)

27616 MATRIX CORRECTED X-RAY FLUOROMETRIC ANALYSIS METHOD. Goldman, Marvin; Anderson, Ruth P. (to United States Atomic Energy Commission). U. S. Patent 3,375,369. Mar. 26, 1968.

X-ray fluorometric analysis of elemental materials present in a matrix of unknown composition as incorporated with low Z binders into a specimen form of predetermined size and weight is discussed. Monochromatic x rays, characteristic of the element to be determined and of known intensity, I_0, are passed through the specimen form and the intensity, I, of the emergent x rays is determined. The ratio $I/I_0 = T$, the transmittance factor of the specimen, is determined. Subsequent irradiation with polychromatic x rays is then employed to ascertain the net characteristic monochromatic fluorescent x-ray output, S, of the unknown amount of the element in the specimen. The amount of the element is then determined using the newly discovered linear relationship between transmittance and sensitivity factors, e.g., by using calibration plots of factors obtained from known composition specimens or by the use of corresponding simple linear equations. (AEC)

27617 METHOD AND APPARATUS FOR MEASURING THE RADIOACTIVITY OF ^{14}C- AND/OR ^{3}H-LABELLED COMPOUNDS. (to Bodenseewerk Perkin-Elmer and Co. GmbH.). British Patent 1,106,189. Mar. 13, 1968. Priority date June 12, 1964, Germany.

A method is described for measuring the radioactivity of compounds labeled with ^{14}C and/or ^{3}H by passing the compounds continuously past a contact of Zn and Ni held at an elevated temperature and then passing the products of the reaction through a flow-through radioactivity detector. The Ni and Zn are in finely divided form on a support, and an additional Ag wool contact may be provided if necessary for complete reaction. The apparatus is particularly applicable to connection to the outlet from a gas chromatographic device. (B.L.M.)

27618 SUBSTOICHIOMETRY IN RADIOCHEMICAL ANALYSIS. Ruzicka, Jaromir; Stary, Jiri. International Series of Monographs in Analytical Chemistry. Volume 30. New York, Pergamon Press, 1968. 151p. $8.00.

The use of substoichiometric separation, which eliminates the necessity of determining the chemical yield of the separation procedures, is discussed with respect to radiochemical analysis. Procedures were developed for the substoichiometric determination of 23 elements by neutron activation analysis and isotopic dilution analysis, and examples of their practical application are given. Other topics discussed include analysis of radiometric materials; automation of substoichiometric analysis; comparison of substoichiometric isotope dilution analysis and other radiometric methods; and trends in substoichiometry. (D.H.M.)

Inorganic, Organic, and Physical Chemistry

Refer also to abstracts 27755, 27767, 27799, 28465, 28795, 28919, 28942, 29926, and 30406.

27619 (CEA-N-816, pp 90-101) ETUDES D'ELECTROMETALLURGIE. (Electrometallurgy Studies). (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). (In French).

Developments are reported for studies on electrochemistry in molten salts and electrocrystallization. The properties of compact deposits of Ta, Ni, Be, and U by electrocrystallization in fused salts are described. Studies of the effects of ultrasonics on electrocrystallization of Ni from aqueous media showed that the effect of ultrasonics on the excess pressure of the deposits depends on the arrangement of the electrodes with respect to the ultrasonic emitter. (P.C.H.)

27620 (CEA-N-816, pp 481-8) ETUDES FONDAMENTALES. (Fundamental Studies). (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). (In French).

Developments are reported for studies on: acid–base properties in concentrated salts containing solutions at 25°C; water and nitric acid extraction by tridodecylamine nitrate organic solutions; and apparent normal potential of the Bk(IV)–Bk(III) couple. (P.C.H.)

27621 (EUR-3893) DIE UNTERSUCHUNG VON TRANSPLUTONIUMELEMENTEN: ERGEBNISSE, PROBLEME UND MOEGLICHKEITEN. (The Investigation of Transplutonium Elements: Results, Problems, and Possibilities). Mueller, W. (European Atomic Energy Community, Karlsruhe (West Germany). Inst. of Transuranium Elements). Mar. 1968. 88p. (In German). Dep.

The preparation, some properties, and possible applications of transplutonium elements available in gram and multigram amounts, are described. Scientific and practical problems associated with the investigation of these elements or their compounds are discussed. (162 references) (auth)

27622 (EUR-3897) TECHNIKEN ZUR UNTERSUCHUNG PLUTONIUMHALTIGER PROBEN MITTELS ROENTGENBEUGUNG. (Techniques for Investigation of Plutonium-Containing Samples by Means of X-Ray Analysis). Benedict, U. (European Atomic Energy Community, Karlsruhe (West Germany). Inst. of Transuranium Elements). Jan. 9, 1968. 23p. (In German). Dep.

Devices and methods for x-ray fine-structure investigations of plutonium-containing samples are described. (auth)

27623 (IS-T-215) THE X-RAY CRYSTAL STRUCTURE DETERMINATION OF $Fe_3(CO)_{11}P(C_6H_5)_3$ AND THE DESIGN, INSTALLATION, AND AUTOMATION OF A NEUTRON DIFFRACTION SYSTEM. Dahm, Donald James (Ames Lab., Iowa). Feb. 1968. Contract W-7405-eng-82. 89p. Dep. CFSTI.

Thesis.

The crystal structure of $Fe_3(CO)_{11}P(C_6H_5)_3$ has been determined from three dimensional x-ray data. Sixteen molecules crystallize in the monoclinic space group $C_{2/c}$ with a = 37.14, b = 12.26, c =

26.05 A, and $\beta = 93.96°$. The structure was refined by full matrix least squares with iron and phosphorus atoms anisotropic to a conventional R value of 0.082 for 1800 reflections collected by counter methods. The structure is similar to that of $Fe_3(CO)_{12}$. The iron atoms form a nearly isosceles triangle with the short side connected by two asymmetric carbonyl bridges. The rest of the carbonyls are terminal. Each asymmetric unit contains two molecules which are structural isomers of one another, with the $P(C_6H_5)_3$ group attached to different iron atoms. On the basis of a qualitative molecular-orbital treatment, a lengthening of iron–iron bonds in $Fe_3(CO)_{11}P(C_6H_5)_3$ as compared to $Fe_3(CO)_{12}$ is rationalized as being due to increased population of antibonding orbitals. A Hilger-Watts four circle neutron diffractometer operates under the control of an SDS-910 computer. The interfacing and programming for the system are of local origin. A neutron beam forming an angle of 90° with the incident beam is taken from a beryllium monochromating crystal located inside the reactor face. Alignment of the diffractometer, both optically and with neutrons, the neutron detection devices, and other aspects of the system are discussed in some detail. (auth)

27624 (LA–3915) SHOCK WAVE COMPRESSION OF BENZENE, CARBON DISULFIDE, CARBON TETRACHLORIDE, AND LIQUID NITROGEN. Dick, Richard Dean (Los Alamos Scientific Lab., N. Mex.). Apr. 1968. Contract W-7405-eng-36. 103p. Dep. CFSTI.

Thesis. Submitted to Arizona State Univ., Tempe.

Shock waves generated by high explosives were used to obtain Hugoniot data for benzene, carbon disulfide, and carbon tetrachloride initially at 300°K and liquid nitrogen initially at 75°K. Electrical pin contactors were used to determine the shock velocity in a dural standard plate and in the liquids. From these data and the known dural equation of state, the Hugoniot curves for the liquids were determined by means of the conservation relations and continuity conditions. Dynamic pressures achieved ranged from 20 to 600 kbar in the samples. A plot of the shock velocity (U_s) versus particle velocity (U_p) data for benzene revealed three regions each of which is described by a linear relationship. This is indicative of a transition occurring at 125 kbar and ending at 180 kbar. The carbon disulfide $U_s - U_p$ plot reveals a lower region fitted by a straight line, a middle region of constant shock velocity, and an upper region fitted by another straight line. The middle portion corresponds to 64 kbar and the liquid is believed to transform at this pressure to the so-called black form of carbon disulfide. Two straight lines with differing slopes describe the $U_s - U_p$ data of carbon tetrachloride. This may be the result of crossing a fusion line. The liquid nitrogen $U_s - U_p$ plot is interpreted to have four possible regions and are a lower portion fitting a straight line, a region of constant shock velocity, a region which fits a straight line of steep slope, and the highest region fitting another straight line. This behavior is hypothesized to be the result of the Hugoniot crossing phase lines in the vicinity of a triple point. Although carbon disulfide and carbon tetrachloride are normally insulators, both become electrically conductive at presures near 70 kbar. Some thermodynamic quantities such as temperatures on the Hugoniot, isentropes, and isotherms were calculated using a computer program fashioned with a thermodynamic description based on the Mie-Gruneisen form for the equation of state. (auth)

27625 (MIT–905–108) CHEMISTRY PROGRESS REPORT. (Massachusetts Inst. of Tech., Cambridge. Lab. for Nuclear Science). Dec. 31, 1967. Contract AT(30-1)-905. 84p. Dep. CFSTI.

Four sections are included; separate abstracts were prepared for each. (P.C.H.)

For abstracts of individual sections see: 27626–27628 and 29983.

27626 (MIT–905–108, pp 33–62) INSTRUMENTAL CHEMISTRY GROUP. (Massachusetts Inst. of Tech., Cambridge. Lab. for Nuclear Science).

Developments are reported for studies on: chloranilate complexes of Th; coordination number of Ag in its tetramethylethylene diamine complex; plasma emission spectroscopy; trace quantities of heavy metals in natural media; analysis of surface adsorbed oxygen on solid electrodes; electrochemistry of single crystal electrodes; experimental evaluation of transition times; mechanism of oxidation of formic acid at a platinum electrode; efficiency of electroluminescence from organic redox reactions; excimer emission-electroluminescence of aromatic hydrocarbons; role of the triplet state in electrochemiluminescence of rubrene; chemiluminescence of luminol; chemiluminescence of electron-transfer reactions; chemiluminescence of lucigenin; chemiluminescence and energy transfer; triplet-singlet energy transfer; triplet state structure; fluorescence of 9-anthroic acid and its derivatives; mechanism in photochemical Fries Rearrangement; photochemistry of anthraquinone; photo- and electrochemistry of phenazine; and electron spectroscopy. (P.C.H.)

27627 (MIT–905–108, pp 63–78) ORGANIC ISOTOPE APPLICATIONS GROUP. (Massachusetts Inst. of Tech., Cambridge. Lab. for Nuclear Science).

Developments are reported for studies on: chlorine isotope effects in reaction of nucleophiles with methyl chloride in 1,2-dimethoxyethane; mechanism of the Cannizzaro reaction; chlorine isotope effects in hydrolysis of substituted cumyl chlorides; chlorine isotope effects in equilibrium between covalent and ionic chloride; electron transfer phenomena; selectivity in free radical reactions; and mechanisms of decomposition of peroxygen compounds. (P.C.H.)

27628 (MIT–905–108, pp 79–80) PHYSICAL CHEMISTRY GROUP. (Massachusetts Inst. of Tech., Cambridge. Lab. for Nuclear Science).

Developments are reported for studies on: determination of vapor-liquid equilibrium by static measurements; and excess free energy and related properties of solutions containing electrolytes. (P.C.H.)

27629 (MLM–1462) EXCHANGE OF ISOTOPICALLY ENRICHED OXYGEN WITH $^{238}PuO_2$ SOL-GEL MICROSPHERES. Plymale, D. L. (Mound Lab., Miamisburg, Ohio). Jan. 2, 1968. Contract AT-33-1-GEN-53. 8p. Dep. CFSTI.

An exchange reaction between $^{238}PuO_2$ sol-gel microspheres and oxygen enriched in ^{16}O was performed at two temperatures, 700 and 850°C. A slower exchange rate was observed at 850°C and was thought to be due to the sintering of the microspheres. A neutron reduction, characteristic of an equilibrium condition, was observed at both temperatures; however, the spheres possessed a high neutron emission, probably due to light element impurities. An exchange reaction at 700°C coupled with sintering at 1200°C for several hours reduced the emission to the predicted value of 5.0×10^3 n/sec-g. (auth)

27630 (ORNL-TM–2203) ABSTRACTS OF PAPERS, WATER AND DESALINATION INFORMATION MEETING, MAY 7–8, 1968. Kraus, K. A.; Hammond, R. P. (Oak Ridge National Lab., Tenn.). May 1968. Contract W-7405-eng-26. 86p. Dep. CFSTI.

Topics covered by the papers include: osmotic and activity coefficients in mixed electrolytes, activity coefficients in pyridine and pyridine sulfate solutions, electrochemistry and corrosion, hyperfiltration, multistage hyperfiltration, hydrodynamic studies, VTE test vehicle, VTE pilot plant, tests on advanced heat transfer surfaces, the multitube condenser test, CO_2 suppression of alkaline scale, tubing fabrication studies, cost effectiveness model for OSW, updated design of 250-Mgd MSF plant, design studies of gas-turbine vapor-compression systems, design and cost studies of large combined VTE-MSF plants, metallic uranium-fueled pressurized-water reactors for process heat or power, unclad metal breeder for process heat or power, parametric study of plants having high water-to-power ratios, vapor compressor design studies, a digital computer program for saturated and low superheat steam turbine cycles, dual-plant control studies, and the nuclear-powered agro-industrial complex. (M.C.G.)

27631 URANIUM OXIDE FLUORIDE. Kemmler-Sack, Sibylle (Univ., Tuebingen, Ger.). Z. Naturforsch., 22b: 593-5(June 1967). (In German).

Uranium oxide fluorides can be prepared by decomposition of UF_4 with UO_2 and UO_3 or U_3O_8 under vacuum at 400 to 550°C. By this method either a homogeneous oxide fluoride with considerable phase regions, in which the oxidation state of uranium is +5 or +5 and +6 mixed, or a stoichiometric compound $UO_2F_{0.25}$, with uranium with a valence of 4 or 5, is formed. (tr-auth)

27632 PHYSICAL PROPERTIES AND CHEMICAL REACTIVITY OF ALTERNANT HYDROCARBONS AND RELATED COMPOUNDS. XV. KINETICS OF THE DEDEUTERATION OF BENZENOID HYDROCARBONS. Parkanyi, C.; Dolejsek, Z.; Zahradnik, R. (Inst. of Physical Chemistry, Prague). Collect. Czech. Chem. Commun., 33: 1211-19(Apr. 1968).

The kinetics of the dedeuteration of a series of eight benzenoid monodeuterated hydrocarbons was studied in the mixture trifluoroacetic acid (91.8 mole %)–perchloric acid (2.5 mole %)–water (5.7 mole %) at 30 ± 0.1°C. A correlation was found between the logarithms of the first-order rate constants (log k) and HMO atom localization energies of the positions in hydrocarbons in which the deuterium atom is bound (A). There is a splitting of data into three groups according to the character of the position bearing the deuterium atom (i.e., benzene-like, α-naphthalene-like, meso-anthracene-like positions). A similar correlation with SCF atom localization energies for electrophilic substitution (A_r^{SCF}), calculated according to Pople's procedure,

gave only one regression line including all three types of positions. A comparison of the plots obtained with analogous plots for the dedeuteration in liquid hydrogen bromide (Šatenštejn) showed that the nature of the reaction remained unchanged in a solvent with a different dielectric constant. (auth)

27633 THE MECHANISM OF EXCHANGE REACTIONS BETWEEN OXYGEN AND OXIDES ZnO, MnO_2, CuO, AND Co_3O_4. Novakova, J.; Jiru, P.; Klier, K. (Inst. of Physical Chemistry, Prague). Collect. Czech. Chem. Commun., 33: 1338-41(Apr. 1968).

The modified gradient method was used to calculate exchange rates of oxygen molecules of varying compositions of $^{18}O-^{16}O$ with solid Co_3O_4, CuO, MnO_2, and ZnO. Data are tabulated. (J.G.B.)

27634 VIBRATIONAL ANALYSIS OF CHAIN FOLDING IN POLYETHYLENE CRYSTALS. Tasumi, M.; Krimm, S. (Univ. of Michigan, Ann Arbor). J. Polym. Sci., Part A-2, 6: 995-1010 (May 1968).

The vibration frequencies of a polyethylene crystal lattice have been computed for various structures in which a fully deuterated chain is mixed with a normal chain. Intermolecular potential functions previously developed were used in the calculation. It is found that such structures make it possible to distinguish experimentally between chain folding in the (110) plane and folding parallel to the (100) plane. Calculations have also been done for a regular polymer of $(CH_2CD_2)_x$. Such a structure would permit the determination of the parity of the number of methylene groups in the fold. (auth)

27635 THE REGULARITY OF THE SOLUBILITY OF HYDROGEN IN THE TRANSITION METALS OF THE VI SUBGROUP. Mazaev, A. A.; Avarbe, R. G.; Vil'k, Yu. N. (State Inst. of Applied Chemistry, Leningrad). Zh. Fiz. Khim., 42: 641-3 (Mar. 1968). (In Russian).

The interaction of metals of the VI subgroup with hydrogen was studied in a wide temperature interval at hydrogen pressures from 1 to 100 atm. The solubility of hydrogen at constant pressure increases exponentially with the increase of temperature. In the first approximation there is proportional dependence of the hydrogen solubility on the square root of P. Equations describing the solubility of hydrogen in metals of the VI subgroup were derived. For Cr, Mo, and W the enthalpy was positive throughout the temperature interval studied (from 0.5 to 0.9 T_{fusion}), and the entropy of solution was negative. The regularity of the changes of these values was established in the transition from Cr to Mo and W. (tr-auth)

27636 THERMODYNAMIC PROPERTIES OF THE TRANSITION METALS AND THEIR COMPOUNDS ON THE BASIS OF A REPRESENTATION OF THE FORMATION OF STABLE CONFIGURATION OF LOCALIZED SECTION OF THE VALENCE ELECTRONS. Pryadko, I. F. (Inst. of Problems of Material Management, Kiev). Zh. Fiz. Khim., 42: 755-60(Mar. 1968). (In Russian).

Calculation of the electron structure during examination of the entropy of transition metals and the heats of formation of different compounds made possible the definite prognosis with respect to their thermodynamic properties and to evaluate the degree of reliability of the experimental and calculated data used. (tr-auth)

27637 POSSIBILITY OF USING SOLID ELECTROLYTES WITH OXYGEN CONDUCTIVITY FOR STUDY OF THE THERMODYNAMIC PROPERTIES OF ALLOYS OF ACTIVE METALS. Vecher, A. A.; Vecher, D. V. (Belorussian State Univ., Minsk). Zh. Fiz. Khim., 42: 799-801(Mar. 1968). (In Russian).

The magnitudes of molecular oxygen current through solid electrolytes with oxygen ion conductivity were calculated on the basis of zirconium oxide and thorium oxide. The size of the p_i^* constants were evaluated for thorium electrolytes and their dependence on the temperature was expressed by equations. The single evidence of the absence of electron conductivity in the solid electrolyte during thermodynamic investigation, was the constant weight of the electrodes of the elements before and after tests. (tr-auth)

27638 XENON ADSORPTION ON GRAPHITIZED CARBON BLACKS OVER A WIDE COVERAGE RANGE. Cochrane, H.; Walker, P. L. Jr.; Diethorn, W. S.; Friedman, H. C. (Pennsylvania State Univ., University Park). J. Colloid Interface Sci., 24: 405-15(1967).

Adsorption isotherms are reported for Xe on 2 graphitized carbon blacks, Sterling MT 3100 and Graphon, at surface coverages ranging from 10^{-10} to 0.9. A tracer method based on ^{133}Xe and a conventional volumetric method were used at the lower and higher coverages, respectively. The small degree of surface heterogeneity associated with both materials was confirmed. Henry's law over the surface coverage range 10^{-10} to 10^{-6} was obeyed by Sterling MT 3100. At higher surface coverages, the adsorbed phase on both carbon blacks was interpreted to be a 2-dimensional mobile layer with adsorbate-adsorbate interactions. Xenon-133 was produced by fissioning ^{235}U, in the form of ~1 g of uranyl nitrate hexahydrate crystals, in a thermal-neutron flux of 9×10^{11} n/cm^2/sec for 2 hr. Eleven radioactive and 5 stable isotopes of Xe are produced in fission, but after 5 days the only significant radioactive Xe isotope present is ^{133}Xe. The Xe was released from the crystals by melting the crystals after evacuation to 10^{-5} torr, in flowing He. The ^{133}Xe was measured by counting the 81-keV photopeak activity with a conventional system. The ^{133}Xe generation and purification system, the flow radiation detector, and the Xe doser were connected to an glass adsorption system, which is illustrated. Four separate ^{133}Xe determinations differed no more than ±4%. The average value of the 2-dimensional critical gas temperature, $T_{2C(app)}$ for Xe on Sterling MT 3100 was 120.6°K; on Graphon, 100.0°K. A higher value of $T_{2C(app)}$ on MT 3100 than on Graphon is consistent with the smaller amount of heterogeneity in the former. The area σ occupied by a Xe atom in a complete monolayer was calculated. On Sterling MT 3100 σ decreased from 24.3 Å^2 at −78°C to 22.7 at 111°C. Values of σ on Graphon showed no significant change with temperature. (BBB)

27639 ISOTOPIC OXYGEN EXCHANGE AND HYDROLYSIS IN DIALKYLPHOSPHONATES. Samuel, David; Silver, Brian L. (Weizmann Inst. of Science, Rehovoth, Israel). J. Phys. Chem., 72: 1809-10(May 1968).

A study was made to determine whether oxygen exchange between substrate and solvent occurred during the acid- and base-catalyzed hydrolysis of dialkyl phosphonates and during the isotopic exchange of hydrogen in dialkyl phosphonates. Oxygen exchange experiments with dipropyl phosphonates show that no oxygen exchange occurred between phosphonates and solvent water for the stated reaction times (which correspond to at least one half-life of the acid-catalyzed hydrolysis and 5 to 10 half-lives of the acid-catalyzed hydrogen exchange). Results show that in the hydrolysis of dimethyl and diethyl phosphonate in both acid and basic solution, the bond between phosphorus and oxygen was broken in every case. (P O-R) (D.H.M.)

27640 EXCHANGE REACTION OF PENTAFLUOROETHYL IODIDE WITH IODINE. Grygorcewicz, C.; Laurence, G. S. (Univ. of Adelaide). J. Phys. Chem., 72: 1811-12(May 1968).

In the range from 120 to 170°C, the thermal exchange rate of the reaction between pentafluoroethyl iodide and iodine was independent of the surface-to-volume ratio of the reaction vessel and reaction was homogeneous. The rate of the thermal exchange was measured as a function of C_2F_5I concentration (1 to 4×10^{-6} mol/cm) and the I_2 concentration (3 to 13×10^{-9} mol/cm) at 140°C. The activation energy for the thermal exchange was 13.5 kcal/mol and the activation energy for photochemical exchange was 14.5 kcal/mol. (D.H.M.)

27641 DIFFERENCES BETWEEN NICKEL DEUTERIDE AND NICKEL HYDRIDE DECOMPOSITION KINETICS. Stroka, A. (Inst. of Physical Chemistry, Pan, Poland). Bull. Acad. Pol. Sci., Ser. Sci. Chim., 16: 65-70(1968).

The decomposition rate at 25°C of nickel hydride was 1.9 times that of the deuteride. The decomposition rate of both hydrides and deuterides was found to be independent of film thickness. The energy of activation of nickel deuteride was found to be less than that of nickel hydride. Measurements were made within the temperature range 15 to 45°C. (J.G.B.)

27642 $Hg(^1P_1)$-PHOTOSENSITIZED DECOMPOSITION OF CYCLOBUTANE. Spittler, E. G.; Klein, G. W. (Mellon Inst., Pittsburgh). J. Phys. Chem., 72: 1432-8(May 1968).

The $Hg(^1P_1)$-photosensitized decomposition of cyclobutane was studied at room temperature in the pressure range 15 to 760 mm. Ethylene was the major hydrocarbon product, accounting for 50% of the total product at 15 mm and over 90% above 300 mm. Other products, in order of decreasing importance, were H_2, cyclobutylcyclobutane, cyclobutene, butane, ethane, propane, and traces of acetylene, propylene, cyclopropane, and a C_5 product (probably methyl cyclobutane). Hydrogen decreased from 50% of the C_2H_4 at 15 mm to <5% of the C_2H_4 above 300 mm. With >5% added C_2D_4, NO, or O_2 at 15 mm, the H_2 yield decreased by 50%; above 300 mm, it decreased by 60 to 80%. These results can be reasonably interpreted in terms of the processes: (1) $Hg(^1P_1) + c\text{-}C_4H_8 \rightarrow Hg(^1S_0) + c\text{-}C_4H_8^*$, (2) $c\text{-}C_4H_8^* \rightarrow 2C_2H_4$, (3) $c\text{-}C_4H_8^* \rightarrow H_2 + c\text{-}C_4H_6$, (4) $c\text{-}C_4H_8^* \rightarrow H + c\text{-}C_4H_7$, (5) $c\text{-}C_4H_8^* \rightarrow CH_2 + C_3H_6$. Reactions 2 to 4 accounted for most of the products at all pressures, with reaction 2 predominating at high pressures. Reaction 5 is suggested to account for the formation of small amounts of methyl

cyclobutane, propylene, and cyclopropane at pressures >400 mm. The marked pressure dependence of the amount and distribution of products indicates that complete quenching of the $Hg(^1P_1)$ atoms did not occur below 400 mm. It also seems necessary to postulate at least two precursors for reactions 2 to 5, at least one of which may be a vibrationally excited ground state of cyclobutane. Using mixtures of $c\text{-}C_4H_8$ and $c\text{-}C_4D_8$, a significant over-all isotope effect was observed for the formation of ethylene. (auth)

27643 RATE OF ISOTOPIC EXCHANGE OF FERROCENE HYDROGEN, AS INFLUENCED BY THE ACIDITY OF THE MEDIUM. Bykova, E. V.; Setkina, V. N.; Kursanov, D. N. Dokl. Akad. Nauk SSSR, 178: 352-4(Jan. 11, 1968). (In Russian).

The rate of isotopic exchange of ferrocene hydrogen in mixtures of various acidities of acetic and trifluoroacetic acids (at H_0 = −1.0 to −2.5) was studied at 25°C. The graphical data indicate that the logarithm of the rate constant of the reaction is a linear function of the acidity, H_0, with the Hammett ratio of lg K + H_0 = const. Comparisons of the isotopic exhange rate constants for benzene and ferrocene at H_0 = −5 and 25°C showed (H_0 = 10^5) for benzene 2.7×10^{-7} sec^{-1} and for ferrocene 1.3×10^{-1} sec^{-1}. Thus, the ferrocene exchange is faster than that of benzene by five or six orders of magnitude. (R.V.J.)

27644 POLYMORPHISM OF URANIUM(IV) FORMATE. Bressat, Rene; Claudel, Bernard; Navarro, Alain (Institut National des Sciences Appliquees de Lyon, Villeurbanne, France). Compt. Rend., Ser. C, 266: 1260-2(Apr. 22, 1968). (In French).

Evidence was found by thermogravimetric, differential thermal and radiocrystallographic analysis for the existence of uranium formate, $U(HCOO)_4$, of three allotropic varities α, β, and γ of which the α is isomorphous with the variety already described for thorium formate, $Th(HCOO)_4$. (P.C.H.)

27645 STRUCTURES OF URANYL CHLORIDE AND ITS HYDRATES. Debets, P. C. (Reactor Centrum Nederland, Petten, Netherlands). Acta Crystallogr., Sect. B, 24: 400-2(1968).

X-ray powder diffraction data for UO_2Cl_2, $UO_2Cl_2 \cdot H_2O$, and $UO_2Cl_2 \cdot 3H_2O$ are presented, together with the unit cells derived from these data. The structures of the three compounds are also given, with some restrictions about the positions of the oxygen ions. From the structure determination it follows that $UO_2Cl_2 \cdot H_2O$ is not a true hydrate. (auth) (Denmark)

27646 MEAN AMPLITUDES OF VIBRATION OF COMPARATIVELY LARGE MOLECULES. I. ISOTOPIC NAPHTHALENES. Hagen, G.; Cyvin, S. J. (Technical Univ. of Norway, Trondheim). J. Phys. Chem., 72: 1446-51(May 1968).

A complete harmonic-vibration analysis for naphthalene was performed. The derived force constants were used to compute mean amplitudes of vibration in naphthalene, naphthalene-d_8, and five selected partially deuterated naphthalenes. It was found possible to present the results as characteristic values for the various types of distances, applicable to any deuterated naphthalene compound. Good agreement with similar data for benzene was also found. (auth)

27647 KINETICS AND MECHANISM OF THE REACTION BETWEEN BROMINE TRIFLUORIDE VAPOR AND URANIUM TETRAFLUORIDE. Sakurai, Tsutomu; Iwasaki, Matae (Japan Atomic Energy Research Inst., Tokyo). J. Phys. Chem., 72: 1491-7(May 1968).

The reaction between BrF_3 vapor and UF_4 was investigated in the temperature range from room temperature to 300°C and a range of BrF_3 partial pressure from 6 to 45 mm. Argon saturated with BrF_3 vapor was introduced into a reactor at a fixed flow rate, and the BrF_3 was treated with the UF_4, the weight change of which was measured by a thermobalance. The reaction mechanism was also studied and UF_5 and UF_{4+x} ($0 < x < 1$) were captured as the intermediates of the reaction. From these experiments it was found that the reaction proceeded even at room temperature; the rate of reaction was proportional to the BrF_3 partial pressure and changed with increasing temperature; at temperatures below 100°C, UF_4 was converted to UF_6 through the reaction $UF_4 \rightarrow UF_{4+x}$ ($0 < x < 1$) $\rightarrow UF_5 \rightarrow UF_6$, at temperatures of 100 to 200°C; however, the reaction mechanism was complicated, probably due to the occurrence of an interaction between the produced UF_6 and the remaining UF_4; and owing to this temperature dependence of the reaction mechanism, the rate constant, calculated from the slope of the weight loss vs time curve, rose to a peak at 185°C and then fell to a minimum at 220°C. The activation energy, calculated from the Arrhenius equation, has a low value of 1.0 kcal/mole. (auth)

27648 VAPORIZATION OF YTTERBIUM DICARBIDE. Haschke, John M.; Eick, Harry A. (Michigan State Univ., East Lansing). Contract AT(11-1)-716. J. Phys. Chem., 72: 1697-1702(May 1968). (COO-716-031).

Samples of ytterbium dicarbide and ytterbium sesquicarbide were prepared by direct reaction of the elements in sealed tantalum bombs. The vaporization of the dicarbide according to the reaction $YbC_2(s) \rightarrow Yb(g) + 2C(s)$ was studied by the target collection Knudsen effusion technique over the temperature range 1100 to 1550°K. An x-ray fluorescence method for analysis of the condensed effusate was developed. Second- and third-law results are reported, and the ΔH^0_{298} of $YbC_2(s)$ was determined to be −18.0 ± 1.0 kcal/gfw. (auth)

27649 KINETICS OF HYDROGEN ISOTOPE EXCHANGE IN BENZENE USING A HOMOGENEOUS PLATINUM CATALYST. Hodges, R. J.; Garnett, J. L. (Univ. of New South Wales, Kensington). J. Phys. Chem., 72: 1673-82(May 1968).

The homogeneous exchange of benzene with isotopic hydrogen was studied in solution in the presence of catalytic amounts of Pt(II) and Pt(IV) salts. Rate of exchange $k_{ex} \propto [PtCl_4^{2-}]\ [C_6H_6]/[Cl^-]$. Both multiple and stepwise processes were observed in the reaction. The acidity of the solution was found to be important for stabilizing the homogeneous catalyst. An isotope effect for k(deuteration)/k(dedeuteration) of 1.65 ± 0.05 was observed. The data are shown to be consistent with a mechanism involving π-complex intermediates. The results of the present homogeneous exchange are shown to be relevant to the interpretation of analogous reactions in heterogeneous catalysis. (auth)

27650 EFFECT OF ENVIRONMENT ON THE ABSORPTION SPECTRA OF PLUTONIUM(VI) IONS. Ekstrom, A. (Univ. of Wisconsin, Madison); Farrell, M. S.; Lawrence, J. J. J. Inorg. Nucl. Chem., 30: 660-4(Feb. 1968).

Measurements were made on the effects of several organic solvents on the absorption spectra of plutonium(VI) ions. The intensities of a number of the prominent absorption bands of this ion were observed to be strongly dependent on their environment, and it is suggested that, in this case, the phenomenon is related to the ability of certain types of solvent molecules to penetrate to the inner co-ordination sphere of the plutonyl ion. (auth)

27651 ELECTRONIC SPECTRAL STUDIES OF SOME URANIUM(V) COMPOUNDS. Selbin, J.; Ortego, J. D.; Gritzner, G. (Louisiana State Univ., Baton Rouge). Inorg. Chem., 7: 976-82 (May 1968).

The following solid compounds were prepared and characterized in inert atmospheres: $MUCl_6$ [M = Rb and $(n\text{-}C_3H_7)_4N$], both new compounds in regard to the cation present; $UCl_5 \cdot SOCl_2$; $UCl_5 \cdot PCl_5$; and $UCl_5 \cdot$ TCAC (TCAC = trichloroacrylyl chloride, $Cl_2C{=}CClCOCl$), a new compound. In addition, solutions of UCl_5 in CCl_4 and $SiCl_4$ were prepared. Infrared spectra were obtained. Electronic spectra in the near-ir and visible region were obtained for the $MUCl_6$ compounds dissolved in $SOCl_2$; for $UCl_5 \cdot$ TCAC dissolved in $SOCl_2$, C_6H_6, CS_2, and CCl_4; for $UCl_5 \cdot SOCl_2$ dissolved in $SOCl_2$ and CCl_4; and for UCl_5 in CCl_4 and $SiCl_4$. Electronic as well as vibronic band assignments were made for these $5f^1$ electronic systems and several of the vibrational frequencies of the UCl_6^- species were deduced from the electronic spectra. The first ESR spectra for pure U(V) compounds, obtained with powdered samples, are reported, and the average g values are all 1.1. (auth)

27652 DIETHYLDITHIOCARBAMATES OF QUADRIVALENT ACTINIDES. Bibler, J. P.; Karraker, D. G. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Inorg. Chem., 7: 982-5(May 1968).

Diethyldithiocarbamates of Th(IV), U(IV), Np(IV), and Pu(IV) were synthesized by the reaction between MCl_4 or $[(C_2H_5)_4\text{-}N]_2MCl_6$ (M = Th, U, Np, or Pu) and LiL [L = $S_2CN(C_2H_5)_2^-$] in anhydrous ethanol. Elemental analyses show that the products have the formula ML_4, and comparison of the infrared spectra of ML_4 compounds and the sulfur-bonded ZnL_2 indicates that all are similarly bonded. X-ray diffraction data indicate that all four compounds are isomorphous. Proton magnetic resonance spectra established the spectroscopic equivalence of all C_2H_5 radicals in $CDCl_3$ and C_6D_6 solutions of ThL_4 and UL_4. The proposed structure for the ML_4 compounds is an eight-coordinate metal ion, bonded by four four-atom chelate rings to the ligands. (auth)

27653 PREPARATION AND SOME REACTIONS OF DIFLUOROBORANE. Coyle, T. D.; Cooper, J.; Ritter, J. J. (National Bureau of Standards, Washington, D. C.). Inorg. Chem., 7: 1014-20(May 1968).

Difluoroborane is produced by the direct interaction of boron trifluoride with diborane in the gas phase at 100° or above. Pyrolysis of BF_3–B_2H_6 mixtures at 250° for periods of 30 min to 1 hr, followed by rapid quenching, yields HBF_2–BF_3 mixtures free of B_2H_6. An alternative, synthetically useful route is the reaction of $HB(OCH_3)_2$ with excess BF_3. Difluoroborane underwent rapid H–F exchange with boron trifluoride and H–D exchange with deuterated diborane but did not exchange boron with diborane. Addition of

difluoroborane to propene and isobutene yields n-propyldifluoroborane and isobutyldifluoroborane, respectively. Reactions with fluoroethylenes give boron trifluoride, ethylfluoroboranes, and less highly fluorinated olefins. (auth)

27654 ELECTRON IMPACT FRAGMENTATION OF $B_{10}H_8(N_2)_2$ AND ISOTOPIC COMPOSITION OF DECABORANE(14). Middaugh, R. L. (Univ. of Kansas, Lawrence). Inorg. Chem., 7: 1011-14 (May 1968).

The mass spectrum of $B_{10}H_8(N_2)_2$, which has a closed polyhedral boron skeleton, was examined and compared with that of decaborane(14), which has an open-faced icosahedral fragment boron skeleton. There was less boron fragmentation from $B_{10}H_8(N_2)_2$ than from $B_{10}H_{14}$. Prominent ions were $B_{10}H_8N_4^+$ and $B_{10}H_8N_2^+$, with no evidence of similar ions with fewer than eight hydrogens. The ion current patterns of these ions were used to determine the per cent of ^{10}B in the sample. Overlapping $B_{10}H_x^+$ ion currents were resolved to show large contributions from species with x even and small or negligible contributions for x odd. Appearance potential differences are 0.60 ± 0.05 V for the loss of one N_2 molecule and 1.80 ± 0.05 V for the loss of two N_2 molecules. Metastable ions indicate the reactions $B_{10}H_8N_4^+ \rightarrow B_{10}H_8N_2^+ + N_2$ and $B_{10}H_8N_2^+ \rightarrow B_{10}H_8^+ + N_2$ take place in the spectrometer. (auth)

27655 NITROPHTHALATES OF URANIUM(VI). Singh, A. J.; Prasad, N. S. Krishna (Bhabha Atomic Research Center, Trombay, India). Indian J. Chem., 5: 573-4(Nov. 1967).

Potentiometric and spectrophotometric studies of UO_2^{2+} complexes with 3-nitro- and 4-nitrophthalic acids indicate the formation of 1:1 complexes in both the cases; stability constants are 0.66×10^4 and 1.04×10^4, respectively. An insoluble complex of 4-nitrophthalic acid corresponding to the formula $UO_2[C_6H_3(COO)_2NH_4NO_2]_2$ was isolated from concentrated solutions of U(VI). (auth)

27656 CONVERSION OF PLATINIC ACID TO PLATINUM BLACK FOR DEUTERIUM EXCHANGE REACTIONS. Paul, S. D.; Bajpai, M. B. (Bhabha Atomic Research Center, Trombay, India). Indian J. Chem., 5: 577-9(Nov. 1967).

Platinic acid, when heated in a tube with biphenyl and water at 150°C for 24 hr, is converted to platinum black catalyst. The catalyst is as active as Adam's catalyst for D-exchange reactions. Hydrochloric acid reduced the activity of the catalyst. (auth)

27657 PURIFICATION AND PROPERTIES OF HYDROGENASES OF DIFFERENT ORIGINS. Yagi, Tatsuhiko; Honya, Masura; Tamiya, Nobuo (Shizuoka Univ., Japan). Biochim. Biophys. Acta, 153: 699-705(Apr. 2, 1968).

Hydrogenase of Desulfovibrio desulfuricans was purified. It was found that highly purified hydrogenase catalyzed the evolution of hydrogen from $Na_2S_2O_4$ in the presence of cytochrome c_3 or methyl viologen and not in the presence of ferredoxin, and the reduction by H_2 of ferricytochrome c_3 or methyl viologen but not of ferredoxin, methylene blue or hexacyanoferrate(III). Hence, H_2: ferricytochrome c_3 oxidoreductase is proposed for the systematic name of Desulfovibrio hydrogenase. It catalyzed the H–^{2}H exchange in the absence of added electron carriers. Hydrogenase of Clostridium pasteurianum (H_2: ferredoxin oxidoreductase EC1.12.1.1) was purified and found to be specific to ferrodoxin and not to cytochrome c_3 or methyl viologen. The optimum pH of the Desulfovibrio enzyme was 5 to 6 (cytochrome c_3-dependent H_2 evolution), 8 to 9 (cytochrome c_3 reduction by H_2), or 6 to 8 (H–^{2}H exchange reaction). K_m value was 7.5×10^{-5} M for ferrocytochrome c_3 in the H_2 evolution reaction. H_2 production from $Na_2S_2O_4$ in the presence of cytochrome c_3 was irreversibly inhibited by CO, but that in the presence of methyl viologen was reversibly inhibited by CO. (auth)

27658 SULFAMATE COMPLEXES OF PLUTONIUM(IV). Cleveland, J. M. (Dow Chemical Corp., Golden, Colo.). Inorg. Chem., 7: 874-8(May 1968).

Spectrophotometric studies indicated that plutonium(IV) is complexed by sulfamate ion but gave no evidence of sulfamate complexes of plutonium(III) and plutonyl(VI). From the influence of sulfamate concentration on the plutonium(IV) spectrum, the stability constant of the monosulfamate complex of plutonium(IV) was calculated to be 1.3 ± 0.4 at 23°C. Spectra of solutions containing predominantly the monosulfamate complex were changed significantly by the addition of sulfamic acid, indicating the formation of a mixed sulfamate–sulfamic acid complex of plutonium(IV), or the interaction of sulfamic acid with sulfamate ion thereby decreasing the concentration of the monosulfamate complex. The latter reaction was verified by determining the solubility of sulfamic acid in ammonium sulfamate and ammonium nitrate solutions, but the extent of interaction (K = 0.3) was insufficient to account fully for the spectral changes observed. It is concluded that mixed sulfamate–sulfamic acid complexes of plutonium(IV) are formed in solutions containing appreciable concentrations of sulfamate ion and sulfamic acid. (auth)

27659 THE SOLVENT ISOTOPE EFFECT ON THE DISSOCIATION OF THE AQUOPENTAAMMINECOBALT(III) ION. Splinter, Roger C.; Harris, Simon J.; Tobias, R. Stuart (Univ. of Minnesota, Minneapolis). Inorg. Chem., 7: 897-902(May 1968).

Potentiometric and spectrophotometric techniques were used to determine the equilibrium constants for three reactions: $Co(NH_3)_5OH^{2+} + H_2O = Co(NH_3)_5OH^{2+} + H_3O^+$; $Co(NH_3)_5OD^{2+} + D_2O = Co(NH_3)_5OD^{2+} + D_3O^+$; and $Co(ND_3)_5OD^{2+} + D_2O = Co(ND_3)_5OD^{2+} + D_3O^+$ at 25°C in a medium with $[ClO_4^-] = 0.3000$ M. Values of log $^*K_1 = -6.22, -6.75$ (89% D_2O), and -6.70 (99% D_2O), respectively, were obtained. Each value of the equilibrium constant was refined by least squares. The partially exchanged species $Co(NH_3)_5OD^{2+}$ was studied using a flow system. Contrary to an earlier report, the aquopentaamminecobalt(III) ion exhibits a rather normal isotope effect, log $(K_H/K_D) = 0.48 \pm 0.01$ (error at the 99% confidence limit). A comparison of the dissociation constant of $Co(NH_3)_5OD^{2+}$ with that of $Co(ND_3)_5OD^{2+}$, log $K_1 = -6.81$ and -6.70 (valid for 100 mol % D_2O), respectively, indicates the size of any secondary isotope effect which arises from the exchange of the 15 ammine hydrogens. (auth)

27660 OXYGEN ISOTOPE EFFECTS IN THE OXIDATION OF WATER BY TRANSITION METAL IONS. Anbar, M.; Pecht, I. (Weizmann Inst. of Science, Rehovoth, Israel). Trans. Faraday Soc., 64: 744-(Mar. 1968).

The isotopic fractionation of oxygen in the oxidation of water by Co(III), Ni(IV), Cu(III), and Fe(phen)$_3^{3+}$ was measured, as well as in the oxidation of water by hypochlorite and persulphate catalyzed by divalent cobalt, nickel, and copper ions. In all reactions studied, the evolved oxygen was depleted in ^{18}O, fractionation factors ranging from 1.0022 to 1.0455. In the metal catalyzed reactions the same fractionation factor ($^{16}O/^{18}O = 1.0293 \pm 0.0006$) was found in all cases, independent of the oxidant or the metal ion catalyst. The mechanisms of oxidation of water are discussed in terms of the isotopic fractionation data. (auth) (UK)

27661 ROTATIONAL EXTENSION OF THE ($c^1\pi$-$a^1\Delta$) SYSTEM OF NH AND ND. Shimauchi, Midori (Kyoiku Univ., Tokyo). Sci. Light (Tokyo), 13: 53-63(1964).

The emission spectra of NH and ND in the region 3200 to 3500 Å with no trace of the N_2 bands were obtained with a high-resolution spectrograph. The light source was a hollow cathode discharge through a mixture of N_2 and H_2, or 99% D_2 diluted with He. The ($c^1\pi$-$a^1\Delta$) system was extended to J = 16 for NH and J = 23 for ND, and the rotational constants applicable for this extended system were obtained by the least square method as follows: NH, $a^1\Delta$: B'': 16.439 ± 0.0067 cm^{-1}, D'': (1.62 ± 0.04)·10^{-3} cm^{-1}; $c^1\pi$: $B'_{\frac{1}{2}}$: 14.151 ± 0.006 cm^{-1}, $D'_{\frac{1}{2}}$: (2.29 ± 0.03)·10^{-3} cm^{-1}, $B'_{\frac{3}{2}}$: 14.168 ± 0.004 cm^{-1}, $D'_{\frac{3}{2}}$: (2.30 ± 0.02)·10^{-3} cm^{-1}. ND, $a^1\Delta$: 8.825 ± 0.0036 cm^{-1}, (4.58 ± 0.10)·10^{-4} cm^{-1}; $c^1\pi$: 7.637 ± 0.003 cm^{-1}, (6.40 ± 0.12)·10^{-4} cm^{-1}, 7.641 ± 0.003 cm^{-1}, (6.40 ± 0.12)·10^{-4} cm^{-1}. The ratios of the corresponding constants of NH to those of ND are considered. (BBB)

27662 ROTATIONAL ANALYSIS OF THE (2,2) BAND OF THE $\alpha^3\pi_i$–$X^3\Sigma^-$) SYSTEM OF ND. Shimauchi, Midori (Kyoiku Univ., Tokyo). Sci. Light (Tokyo), 16: 185-90(July 1967).

The rotational structure of the (0,0) and (1,1) bands of the ($\alpha^3\pi_i$–$X^3\Sigma^-$) system of ND was studied, along with the rotational constants, B, D, and H, of the lower state and the spin splitting constants, λ and γ, of this state. The process for obtaining the constants of the $\alpha^3\pi_i$ state for ND is explained. First, the term values of the $\alpha^3\pi_i$ state were determined by adding the term value of the appropriate lower level, calculated from the lower state rotational constants including the λ and γ values, to each line in the band, by which means the Λ splitting of each level of the upper state was found. On the assumption that the level of $^3\pi$ state has the mean energy of the Λ doublets the values of constants B, D, and H, the band origin and the coupling constant, A, were obtained using formulas of the $^3\pi$ state. A review of the isotope relations between B_e values of ND and NH in the $X^3\Sigma^-$ and the $\alpha^3\pi_i$ states is given. In the region of the (0,0) and (1,1) bands of ND there is the (2,2) band, which has Q lines as strong as P and R lines of the (0,0) and (1,1) bands. Therefore, it was expected that the rotational constants of the (0,0) and (1,1) bands would be improved after analysis of the (2,2) band. Some P lines of middle N were found. Since the lower state is the stable ground state, the $v'' = 2$ level should have constants approximately equal to those predicted from the constants of the $v'' = 0$ and $v'' = 1$ levels. The correct numbering of the (2,2) band and the picking up of R lines were performed simultaneously. All the assigned lines are listed. The rotational constants for $v = 2$ levels of the $X^3\Sigma^-$ and the $\alpha^3\pi_i$ state of ND are as follows: $X^3\Sigma^-$, $v'' = 2$: $B''_{\frac{1}{2}}$, 8.2745 ± 0.0005 cm^{-1}; $D''_{\frac{1}{2}}\cdot10^4$, 4.73 ± 0.02 cm^{-1}; $H''_{\frac{1}{2}}\cdot10^8$, 1.36 ± 0.12 cm^{-1}; $\alpha^3\pi_i$, $v' = \frac{1}{2}$: $B'_{\frac{1}{2}}$, 8.1754 ± 0.0005 cm^{-1}; $D'_{\frac{1}{2}}\cdot10^4$, 5.08 ± 0.02 cm^{-1}; $H'_{\frac{1}{2}}\cdot10^8$, 0.56 ± 0.11 cm^{-1}; $\alpha'_{\frac{1}{2}}$, −34.52 ± 0.68 cm^{-1}; $\gamma'_{\frac{1}{2}}$, 0.009 cm^{-1}; $\upsilon_{2,2}$, 29658.19 ± 0.02 cm^{-1}; Λ-splitting consts: C_e, −2.40 ± 0.08 cm^{-1}; C_2, 0.0077 ±

0.0006 cm^{-1}; $C_3 \cdot 10^6$, −0.8 + 0.6 cm^{-1}. These values are compared with those calculated by linear extrapolation of literature data and with data for NH. (BBB)

27663 AUTOCATALYTIC PRECIPITATION OF URANIUM FROM CARBONATE SOLUTIONS BY REDUCTION. Zivanov, Z. (Univ. of Novi Sad, Yogoslavia). Int. Chem. Eng., 7: 403-7(July 1967).

In an economical method of obtaining U from solutions of U-poor ores U is reduced in a simple autocatalytic process. The method is based on the fact that U^{6+} does not form carbonate complexes and that it is insoluble in carbonate solutions. The precipitation is accomplished by reduction of U^{6+} to U^{4+} by the use of H_2 under pressure at an elevated temperature in the presence of metallic Ni as catalyst. At temperatures below 180°C, U can be precipitated from carbonate solutions in the form of the oxide by means of CO at partial pressures of more than 15 atm. The precipitation reaction has an induction period in which the U tricarbonate complex undergoes hydrolysis, upon which the uranate forms, which acts as a catalyst in the further course of the reaction. Because the reduction of the U is accomplished by nascent H_2 that results from the activated adsorption of molecular H on the particles of the uranate, or UO_2, the Co can be replaced by gaseous H_2. By the same token the secondary reactions that accompany the precipitation of U by Co and lead to decomposition of the carbonate are eliminated. Thus, when the reaction is carried out in the temperature range of the hydrolytic decomposition of the U tricarbonate complex, the process of catalytic reduction of U^{6+} is reduced to a simple autocatalytic process. (BBB)

27664 AN ELECTROPHORETIC INVESTIGATION OF THE BEHAVIOR OF MONODISPERSE POLYSTYRENE LATTICES IN SOLUTIONS OF LANTHANUM, NEODYMIUM, AND THORIUM NITRATES. Ottewill, R. H.; Shaw, J. N. (Univ. of Bristol, Eng.). J. Colloid Interface Sci., 26: 110-19(Jan. 1968).

An electrophoretic examination of the behavior of latex particles in the presence of La, Nd, and Th was made. The monodisperse polystyrene particles, varying in dia from 600 to 4230 Å, were investigated at constant pH as a function of the concentration of La and Th nitrate solutions. Measurements were made in La nitrate solutions at pH values of 4.5, 5.5, and 7.0 and in Th nitrate solutions at pH 4.5. Reversal of the charge on the particles occurred at all pH values, and in the case of La nitrate the reversal of charge concentration was pH dependent. The effect of particle size was small. Investigations were also made of the electrophoretic behavior of the latex particles in 10^{-5}M La and Nd nitrate solutions as a function of pH. Reversal of charge was observed at pH 4.2 and 7.6 and maxima in positive mobilities occurred at pH 5.4 and 7.1. These results were considered in terms of the known hydrolysis behavior of the La^{3+} and Nd^{3+} ions. (BBB)

27665 COMPARATIVE RATE OF OXIDATION OF ^{234}U AND ^{238}U ATOMS IN CERTAIN MINERALS. Chalov, P. I.; Merkulova, K. I. (Inst. of Physics and Mathematics, Frunze, USSR). Dokl., Earth Sci. Sect. (Engl. Transl.), 167: 146-8(Mar.-Apr. 1966).

The rate of oxidation of ^{234}U and ^{238}U in pitchblende, uranium black, uranophane, mixed phosphorous-arsenic mica, monoazite, and a tantaloniobate mineral was studied. The experimental procedure involved separating the U in the minerals into fractions of different valency (tetra- and hexavalent U), with subsequent determination of the $^{234}U/^{238}U$ ratio. The effect of the more rapid oxidation of ^{234}U as compared with ^{238}U was observed for pitchblende and uranium black. As expected, the minerals containing only U^{6+} showed equal isotopic ratios for total and U^{6+}. For monazite the rate of oxidation of ^{234}U and ^{238}U was the same. The results indicate that the natural dissolution of U from minerals may lead to a partial separation of ^{234}U and ^{238}U on account of the more rapid oxidation of ^{234}U when U is leached from minerals containing U oxides. Radioactive recoil may be important here, for the formation of ^{234}U recoil atoms leads to a more rapid oxidation of ^{234}U as compared with ^{238}U. The results also show that in certain instances, if U is incompletely oxidized to the 6+ state on the decomposition of a sample, the possibility of the true ratio in it being slightly overestimated cannot be precluded. (BBB)

27666 METAL-CHLORIDE COMPLEXES STUDIED BY ION EXCHANGE AND SOLVENT EXTRACTION METHODS. II. TRANSITION-METAL ELEMENTS AND THE HEXAVALENT ACTINIDES. Marcus, Y. (Hebrew Univ., Jerusalem). Coord. Chem. Rev., 2: 257-97(Oct. 1967).

A review is presented of the chloride complexes formed by transition metal elements and the actinides, especially the separation of these metal chloride complexes by ion exchange and solvent extraction methods. The metal chloride complex species predominant in HCl solutions of various concentrations, as obtained from ion-exchange and solvent-extraction data, are tabulated. Data are given for 0.1 to 0.5, 0.5 to 2, 2 to 4, 4 to 6, 6 to 9, and 9 to 12M HCl for the following ions U(IV), U(VI), Th(IV), Pu(IV), Al(III), Sc(III), Y(III), La(III), Lu(III), Am(III), Cf(III), Zr(III), Hf(IV), V(V), Nb(V), Ta(V), Pa(V), Mo(VI), W(VI), Mn(II), Fe(III), Co(II), Ni(II), Ru(III), Ru(IV), and Rh(III). The complexes are considered in detail according to the following periodic groups: VIb and the hexavalent actinides, VIIb, VIII, Ib, and IIb. (239 references) (BBB)

27667 SECONDARY KINETIC DEUTERIUM ISOTOPE EFFECTS IN NUCLEOPHILIC ADDITION REACTIONS TO CARBONYL COMPOUNDS. I. ADDITION OF BH_4^- ION. Geneste, P.; Lamaty, G. (Faculte des Sciences, Montpellier, France). Bull. Soc. Chim. Fr., 2: 669-80(Feb. 1968). (In French).

The secondary kinetic deuterium isotope effects were measured for the addition reaction of BH_4^- ion to carbonyl compounds. The ketones used as substrates were selected mainly for their interest in conformational analysis; the isotope effect was always an inverse effect and was equal to: 0.96 for acetone; 0.92 for diethylketone; 0.99 for acetophenone; 0.95 for cyclopentanone; 0.89 for cyclohexanone; 0.88 for 4-Butylcyclohexanone; 0.91 for cycloheptanone; 0.96 for norcamphor, and 0.95 for cis-2-decalone. The structure of the transition state is discussed and the results interpreted in terms of electronic and steric factors. The main factor thought to be responsible for the observed inverse effect is a difference in the hyperconjugative stabilization between the ketone and its deuterated homologue. The replacement of an H by a D atom caused, however, an increase of the torsional strain in the transition state and this short range steric effect influenced the total effect. (auth)

27668 GAS CHROMATOGRAPHIC DETERMINATION OF REVERSIBLE ADSORPTION OF HYDROGEN. VI. THE H_2–D_2 EXCHANGE REACTION ON A COPPER CATALYST IN RELATION TO THE REVERSIBLE ADSORPTION OF HYDROGEN. Shigehara, Yoshiko; Ozaki, Atsumu (Tokyo Inst. of Tech.). J. Catal., 10: 183-7(Feb. 1968).

The H_2-D_2 exchange reaction on a copper catalyst was examined by means of a pulse flow technique in relation to the reversible adsorption of hydrogen. The Arrhenius plots of the exchange activity showed a break around 20°C at which the reversible adsorption of hydrogen reached a maximum. This result suggests that the exchange reaction at lower temperatures takes place on special sites of higher activity but of smaller number and other than those for the reversible adsorption at lower temperatures, and another type of site of lower activity but of larger number operates at temperatures higher than about 20°C, which are responsible for the reversible adsorption above 20°C. (auth)

27669 MAGNETIC SUSCEPTIBILITY OF SOME THORIUM COMPOUNDS. Belova, V. I.; Syrkin, Ya. K.; Molodkin, A. K.; Ivanova, O. M.; Shiporina, L. M. Zh. Neorg. Khim., 13: 1458-60(May 1968). (In Russian).

Numerical values of magnetic susceptibility of complex thorium compounds with sulfate, oxalate, nitrate, carbonate, and other acidic groups are tabulated. (R.V.J.)

27670 ELECTROPHILIC SUBSTITUTION AT SATURATED CARBON. XL. CHARGE DISTRIBUTION EFFECTS ON KINETIC COMPONENTS OF RACEMIZATION AND ISOTOPIC EXCHANGE OF ISOMERIC FLUORENYL CARBON ACIDS. Ford, Warren T.; Cram, Donald J. (Univ. of California, Los Angeles). J. Amer. Chem. Soc., 90: 2612-22(May 8, 1968).

The kinetics of hydrogen isotope exchange and racemization of optically active and 9-deuterated 2-(N,N-dimethylcarboxamido)-9-methylfluorene (I) and 3-(N,N-dimethylcarboxamido)-9-methylfluorene (IV) with n-propylamine were studied in tetrahydrofuran. Over most of the range of base concentration studied, (+)-I-h, (+)-IV-h, and (−)-IV-d racemized by third-order kinetics and underwent isotopic exchange by a mixture of second- and third-order kinetics. Second-order isotopic exchange occurred with very high retention of configuration for (+)-I-d, k_e/k_α values (ratio of rate constants for exchange and racemization) being greater than 93. This value dropped to $k_e/k_\alpha > 2.5$ for (−)-IV-d. Third-order isotopic exchange occurred with high retention (k_e/k_α = 14 to 54) for (+)-I-d but with net inversion (k_e/k_α = 0.45 to 0.89) for (−)-IV-d. Third-order racemization of (−)-IV-d included a sizable isoinversion (inversion without exchange) component. Isomer IV (3-amide) exchanged 1.1 to 1.4 times faster and racemized 75 to 86 times faster than isomer I (2-amide). The entire racemization rate factor was due to a more negative entropy of activation for (+)-I-h. The isotope effects for racemization of (+)-IV-h and (−)-IV-d decreased dramatically with temperature, and racemization of (+)-IV-h proceeded with significantly lower enthalpy and entropy of activation than did the racemization of (−)-IV-d. The second-order kinetics are interpreted as reflecting reaction between amine monomer and carbon acid, and the third-order reaction between amine dimer and carbon acid. The isotopic exchange with

retention is interpreted as occurring through ammonium carbanide contact ion pair. Rotation of the ammonium ion within the ion pair and collapse to the covalent state provide exchange with retention. The isoinversion and inversion with exchange components are interpreted in terms of a conducted-tour mechanism. Here the amine-complexed ammonium ion migrates along the negatively charged π cloud to the oxygen of the 3-amide group, into the plane of the fluorene system, back to the 9 position on the side remote from the origin, all without hydrogen-bond dissociation. Collapse to the covalent state before amine rotation occurs provides isoinversion, and after, inversion with exchange. The difference in results between the 2- and 3-amide is attributed to charge distribution effects, charge being better distributed on the oxygen of the 3- than of the 2-amide. The kinetic isotope effects are interpreted in terms of a combination of normal and proton tunneling effects. (auth)

27671 ELECTROPHILIC SUBSTITUTION AT SATURATED CARBON. XXXIX. KINETICS OF ISORACEMIZATION OF A FLUORENYL CARBON ACID. Ford, Warren T.; Carm, Donald J. (Univ. of California, Los Angeles). J. Amer. Chem. Soc., 90: 2606-11(May 8, 1968).

The kinetics of tri-n-propylamine-catalyzed isotopic exchange and of racemization of (–)-2-(N,N-dimethylcarboxamido)-7-nitro-9-methylfluorene-9-d ((–)-V-d) in t-butyl alcohol–tetrahydrofuran 20:80 by volume were studied. The racemization reaction was first order in carbon acid over a concentration range of 0.0084 to 0.101M. The changes in second-order rate constant for racemization as the amine concentration varied from 0.0168 to 1.08M and from 0.0729 to 1.07M for exchange were small enough that both reactions are properly considered first order in amine. The rate constant for exchange (k_e) decreased by a factor of 3 as the amine concentration was increased by a factor of 16. The rate constant for racemization decreased by 30% as the amine concentration was increased by a factor of 16. These trends are attributed to the change of dielectric constant of the medium as the amine concentration increased. The activation parameters for isotopic exchange were $\Delta H^{\ddagger} = 7.1 \pm 0.9$ kcal/mol and $\Delta S^{\ddagger} = -54 \pm 4$ eu, and for racemization were $\Delta H^{\ddagger} = 10.5 \pm 0.5$ kcal/mol and $\Delta S^{\ddagger} = -39 \pm 2$ eu. Values of k_e/k_α ranged from a low of 0.10 at 10 mol % amine to a high of 0.22 at 0.6 mol % amine concentration. Concentrations of tri-n-propylammonium iodide or tetra-n-butylammonium iodide of 0.0001M had no effect on k_e/k_α values (~0.1), but concentrations of 0.03M of either salt produced values of unity. The observed isoracemization (intramolecular) is interpreted as occurring through a series of contact ion pairs by a conducted tour mechanism. The slower isotopic exchange is interpreted as involving reaction of solvent-separated ion pairs with solvent. The increase in the isotopic exchange rate relative to racemization when salts are added is interpreted in terms of salt catalyzing the formation of solvent separated from contact ion pairs. (auth)

27672 ELECTROPHILIC SUBSTITUTION AT SATURATED CARBON. XXXVIII. SURVEY OF SUBSTITUENT EFFECTS ON STEREOCHEMICAL FATE OF FLUORENYL CARBANIONS. Cram, Donald J.; Ford, Warren T.; Gosser, Lawrence (Univ. of California, Los Angeles). J. Amer. Chem. Soc., 90: 2598-2606(May 8, 1968).

A survey was made of the values of k_e/k_α (one-point rate constant for base-catalyzed isotopic exchange over that for racemization) for five deuterated, optically active, 9-methylfluorenyl systems substituted with amido, nitro, and cyano groups. The syntheses of optically active 9-deuterio-9-methylfluorenyl systems with the following substituents are described: 2-cyano (II, 2-nitro (III), 3-N,N-dimethylcarboxamido (IV), and 2-N,N-dimethylcarboxamido-7-nitro (V). The k_e/k_α values of these compounds and those of 2-(N,N-dimethylcarboxamido)-9-methylfluorene (I) were found to vary markedly with changes in substituent character, substituent position, media, and pK_a relationship between carbon acid and the conjugate acid of the base employed. In tetrahydrofuran–t-butyl alcohol with tri-n-propylamine as base, the 2-amido system I undergoes isotopic exchange with retention of configuration under conditions that the other four systems (II–V) give isoracemization (intramolecular racemization). The 2-amido system I gives high retention with n-propylamine in tetrahydrofuran, whereas the 3-amide IV and 2-amido-7-nitro system V give low retention and total racemization, respectively, under the same conditions. The 2- and 3-amides in methanol–potassium methoxide gave predominantly racemization with exchange, and reaction rates separated only by a factor of 2. With nitro amide V, substitution of p-methylaniline in tetrahydrofuran for n-propylamine in tetrahydrofuran changed the stereochemical result from total racemization with exchange to high net retention. A rough comparison of the kinetic acidities of the hydrocarbons is made. These facts are interpreted in terms of the behavior of ammonium carbanide ion pairs, whose stereochemical fates depend on the relative rates of up to four fast processes: ion-pair dissociation, alkylammonium ion rotation, carbanion rotation, and proton capture. Particularly striking is the importance of charge distribution in the anion in making carbanion rotation competitive with the other processes. (auth)

27673 ^{19}F NUCLEAR MAGNETIC RESONANCE CHEMICAL SHIFT OF HYDROFLUORIC ACID IN H_2O AND D_2O SOLUTIONS. Schaumburg, K.; Deverell, C. (National Research Council of Canada, Ottawa). J. Amer. Chem. Soc., 90: 2495-9(May 8, 1968).

Values of the ^{19}F chemical shift in aqueous solutions containing HF in the presence of varying amounts of potassium fluoride are reported. Both HF–KF–H_2O and HF–KF–D_2O systems were investigated. The chemical shifts of the species $F^-(H_2O)_x$, HF, HF_2^-, $F^-(D_2O)_x$, DF, and DF_2^- are derived from the concentration dependence of the exchange averaged ^{19}F shift. The results obtained show that isotopic substitution of hydrogen by deuterium produces high-field shifts of several parts per million for the F^- ion and HF molecule resonances in solution. (auth)

27674 FLUORIDE COMPLEXES OF NEPTUNYL(VI). Ahrland, Sten; Brandt, Lars (Univ. of Lund, Sweden). Acta Chem. Scand., 22: 106-14(1968).

Complex formation between neptunyl(VI) and fluoride ions in aqueous solution was investigated at 21°C by means of an extraction method, involving equilibration of the neptunyl(VI) between the aqueous phase and a solution of dibutyl phosphate (DBP) in carbon tetrachloride. In order to prevent the hydrolysis of neptunyl(VI), and also in order to keep the DBP in the organic phase, as is desired, the aqueous phase must have a fairly high acidity. As ionic medium in this phase, 1M perchloric acid was chosen. The volatility of this medium also facilitates the analytical procedure. Within the range of concentrations investigated (neptunyl(VI) ≤ 0.44 mM; hydrogen fluoride ≤ 4.51 M), only two complexes, NpO_2F^+ and NpO_2F_2, are formed. Their "acid" stability constants are $\beta_1^* = 8.6 \pm 2.1$ and $\beta_2^* = 13 \pm 3$, respectively. Further, the constant for the DBP extraction reaction is $K = (2.0 \pm 0.1) \times 10^4$. The fluoride complexes of neptunyl(VI) are weaker than those of uranyl(VI). (auth) (Denmark)

27675 EXCHANGE REACTION OF OXYGEN WITH OXIDES COMPUTER DETERMINATION OF THE EXCHANGE RATES. Muzykantov, V. S.; Jiru, P.; Klier, K.; Novakova, J. (Inst. of Physical Chemistry, Prague). Collect. Czech. Chem. Commun., 33: 829-35(Mar. 1968).

Exchange reactions of oxygen and oxides V_2O_5, WO_3, and MgO were followed by measuring the time dependence of concentrations of $^{18}O^{16}O$, $^{18}O^{18}O$, and $^{16}O^{16}O$. The rates by which the oxygen molecules exchanged their atoms with the oxides by different statistical mechanisms were determined by an optimization method using computer fitting of the theory to experimental data. (auth)

27676 STUDIES ON THE HYDROLYSIS OF METAL IONS. 60. HYDROLYSIS OF THE THORIUM(IV) ION IN 3 M (Na)Cl MEDIUM. Hietanan, Sirkka; Sillen, Lars Gunnar (Royal Inst. of Technology, Stockholm). Acta Chem. Scand., 22: 265-80 (1968).

The hydrolysis equilibria of Th^{4+} were studied at 25°C in the medium 3M (Na)Cl, using hydrogen (and occasionally glass) electrodes, in a concentration range for Th between 0.100 and 0.0001M. Data are given in the form $Z(\log h)_B$. A large number of combinations of hydrolysis products $Th_q(OH)_p$ were tried in order to get the best fit with the data, using the generalized least-squares program LETAGROP. The "best" set was sought under different conditions: $q \leq 4$; thus at most, 4 Th in a complex; $q \leq 5$; $q \leq 6$; and no restriction on q. The "best" combinations of complexes and equilibrium constants on each assumption are given. It was concluded that hexanuclear complexes are an important product, even if, in view of Johansson's recent x-ray work, they are not likely to be regular octahedra. (auth) (Denmark)

27677 STUDIES ON THE HYDROLYSIS OF METAL IONS. 59. THE URANYL ION IN MAGNESIUM NITRATE MEDIUM. Schedin, Ulla; Frydman, Mina (Royal Inst. of Tech., Stockholm. Research Inst. of National Defence, Sundbyberg, Sweden). Acta Chem. Scand., 22: 115-27(1968).

The hydrolysis equilibria of uranyl ions in 3 and 5M (Mg)NO_3 were studied at 25°C using a glass electrode. Around 30 species (p,q) = $(UO_2)_q(OH)_p^{(2q-p)+}$ were tried in the LETAGROP "species selector." The "best" set of complexes chosen were (2,2), (5,3), and (1,1). Their equilibrium constants were, in 5M (Mg)NO_3, $\log \beta_{2,2} = -6.52 \pm 0.02$, $\log \beta_{5,3} = -17.76 \pm 0.02$, $\log \beta_{1,1} = -5.53 \pm 0.25$, and in 3M (Mg)$NO_3$ $\log \beta_{2,2} = -6.34 \pm 0.03$, $\log \beta_{5,3} = -17.37 \pm 0.04$, $\log \beta_{1,1} = -5.38$ (max –5.14), where $\beta_{p,q}$ is the equilibrium constant of $qUO_2^{2+} + pH_2O = (UO_2)_q(OH)_p^{(2q-p)+} + pH^+$. For future work on plutonium, a titration assembly was needed that used only a few milliliters and could be safely handled in a glove box. Several assemblies were developed and tested on the present system. The good agreement between a $Z(\log h)_B$ curve obtained in the "deci-

liter apparatus" and the corresponding curve obtained with the "milliliter assembly" in a glove box is shown. (auth) (Denmark)

27678 SYNTHESIS AND IDENTIFICATION OF SOME MESITYL DERIVATIVES OF POLONIUM. Zhuravlev, V. E.; Antipina, N. F. Radiokhimiya, 9: 726-7(1967). (In Russian).

The possibility of the synthesis of mesityl derivatives of Po by means of the Grignard reaction was found. The following compounds of Po were synthesized and identified by chromatographic methods: $(C_9H_{11})_2Po$, $(C_9H_{11})_2PoCl_2$, $(C_9H_{11})_2PoBr_2$, and $(C_9H_{11})_2PoO$. (tr-auth)

27679 ABOUT THE ISOTOPIC EXCHANGE OF THE HYDROGEN ATOMS TAKING PART IN THE FORMATION OF KETONE ENOLIC FORMS IN THE MASS-SPECTROMETER INLET SYSTEM. Gorfinkel, M. I.; Chirkova, M. A.; Lomm, Mari-Frans. Izv. Sib. Otd. Akad. Nauk SSSR, Ser. Khim. Nauk, No. 12, 116-18 (Sept. 1967). (In Russian).

A method was developed to determine the number of hydrogen atoms taking part in the formation of enolic forms of fatty-aromatic ketones and of saturated cyclic ketones with the CO-group in the ring. The method is based on isotopic exchange of submilligram amounts of ketones with $DN(C_2H_5)_2$ directly in the inlet system of the instrument. (auth)

27680 REACTIONS OF THORIUM, NIOBIUM, AND TANTALUM WITH QUERCITIN. Biryuk, E. A.; Nazarenko, V. A.; Antonovich, V. P.; Ravitskaya, R. V. (Odessa Labs. of the Inst. of General and Inorganic Chemistry). Ukr. Khim. Zh., 34: 291-6(1968). (In Russian).

Spectrophotometric studies of thorium, niobium, and tantalum reactions with quercetin showed that Th forms a complex with the component ratio 1:2, with complex forming ion $Th(OH)_4^{2+}$; Nb and Ta react in acid media forming complexes 1:1 with complex ion $Ta(OH)_4^+$ and $Nb(OH)_4^+$. A single charge anion appears to act as quercetin coordinating ion. All the complexes are neutral. Formulas for the complexes are included. (R.V.J.)

27681 BROMIDE ANION COMPLEXES WITH URANYL IONS IN NONAQUEOUS SOLUTIONS. Belyaev, Yu. I.; Vdovenko, V. M.; Skoblo, A. I.; Suglobov, D. N. Radiokhimiya, 9: 720-3(1967). (In Russian).

During the interaction of a benzene solution of tetradecylammonium bromide with excess uranyl bromide in solution, a complex of the composition $[UO_2Br_3]^-$ was formed. Its infrared and visible spectra were measured. As it is unsaturated coordinately, this compound incorporates other ligands with the formation of the complexes $[UO_2Br_3L]$, (L = Cl^-, Br^-, I^-, SCN^-, NO_3^-, ClO_4^-, TBPO, TBP, $(C_4H_9)_2O$, CH_3SCN, and CH_3CN). (tr-auth)

27682 COMPLEX FORMATION OF TRIVALENT PLUTONIUM, AMERICIUM, AND SOME RARE EARTH ELEMENTS. Moskvin, A. I. Radiokhimiya, 9: 718-20(1967). (In Russian).

The stability constants of Pu, Am, and some rare earth element complexes were compiled from the literature and compared. These published data indicated that the actinide elements Pu and Am form more stable complexes than the lanthanides. (J.S.R.)

27683 DETERMINATION OF THE STABILITY CONSTANTS OF COMPLEXES OF Am AND Cm WITH EDTA BY THE ELECTROMIGRATION METHOD. Lebedev, I. A.; Maksimova, A. M.; Stepanov, A. V.; Shalinets, A. B. Radiokhimiya, 9: 707-9(1967). (In Russian).

The stability constants of complexes of Am and Cm with EDTA were determined by the electromigration method. The rate of Am and Cm migration as a function of hydrogen ion concentration in the 5×10^{-4} M EDTA–sodium salt solution was measured. Stability constants calculated from the experimental data were compared with the values obtained in previous studies using ion exchange and extraction methods. The present results agreed well with those obtained by extraction methods, but were lower than those obtained by ion exchange methods. (J.S.R.)

27684 ELECTRIC DIPOLE MOMENT OF CH_3D. Muenter, J. S.; Kaufman, M.; Klemperer, William (Harvard Univ., Cambridge, Mass.). J. Chem. Phys., 48: 3338-9(Apr. 1, 1968).

Observed Stark coefficients yielded a value for the dipole moment of CH_3D in its ground vibrational state of 0.011274 ± 0.000005 D. (M.C.G.)

27685 INFRARED INTENSITIES OF ν_2 OF ISOTOPIC WATER SPECIES IN NON-AQUEOUS SOLVENTS. Swenson, C. A. (Univ. of Iowa, Iowa City). Spectrochim. Acta, Part A, 24: 721-6(June 1968).

Absolute infrared intensities of the bending vibration ν_2 for the isotopic species of water were measured in nonaqueous media. The experimental intensity of the isotopic species, HDO, was found to be anomalously high when compared to H_2O and D_2O. For this normal mode of HDO the actual molecular motion is described by the usual normal coordinate plus a compensating molecular rotation which oscillates the permanent dipole moment and contributes intensity to the vibrational spectrum. This rotational contribution was calculated for HDO in the gas phase and when applied to the measurements in solution is able to explain the observed intensity. (auth)

27686 INVESTIGATION OF THE COMPLEX FORMATION OF Ce(III), Am(III), Cm(III), WITH 1,2-DIAMINCYCLOHEXANETETRAACETIC ACID BY THE ELECTROMIGRATION METHOD. Stepanov, A. V.; Makarova, T. P.; Maksimova, A. M.; Shalinets, A. V. Radiokhimiya, 9: 710-13(1967). (In Russian).

By means of the electromigration method, it was established that in solutions of 1,2-diamincyclohexanetetraacetic acid, indexed as (1,2-cyclohexylenedinitrilo)tetraacetic acid, in the pH range from 2 to 3.0, Am^{3+}, Cm^{3+}, and Ce^{3+} form complex compounds of the composition $[MA]^-$ and $[MHA]^0$. The stability constants of complexes of Am, Cm, and Ce were calculated for solutions with $\mu = 0.1$ and t = 20°C. (tr-auth)

27687 FUSIBILITY DIAGRAM OF THE SYSTEM U_3O_8–Na_2SO_4. Val'tsev, V. K. Radiokhimiya, 9: 733-6(1967). (In Russian).

The melting diagram of the U_3O_8–Na_2SO_4 system was constructed. It was found that there is an equilibrium between the fused and solid phases in the system. The solid phase was formed as a result of the precipitation of sodium biuranate from the melt. It was assumed that the sodium biuranate can be obtained as the result of the thermal dissociation of the products of interaction between U_3O_8 and sodium nitrate. (tr-auth)

27688 KINETICS OF THE ION EXCHANGE ON PHOSPHORIC ACID SORBENTS WITH DIFFERENT SHAPES OF THE PARTICLES. Paramonova, V. I.; Akopov, G. A.; Kochevanova, L. A. Radiokhimiya, 9: 642-52(1967). (In Russian).

The diffusion equations of sorption kinetics using sorbents of cylindrical form of infinite length were derived. The values of F (degree of equilibrium achieved) were calculated for the Bessel functions tabulated from 0.001 to 1. The experimental confirmation of the equations derived was found, using the sorption of uranium from acetate and nitrate solutions with phosphorylated polyvinyl alcohol fibers (PVA) as an example. On the basis of the data obtained on the dependence of the sorption rate on the radius of the sorbent particles, it was established that one of the processes determining the velocity of the sorption of uranium by phosphoric acid sorbents is the diffusion of uranyl ions within the sorbent. The diffusion coefficients of uranyl ions and the activation energies for the phosphoric acid sorbents KF-11 and PVA were calculated. It was established that the acetate complex formation does not affect the sorption kinetics of uranyl ions from solutions with ionic strength equal to 2 or pH = 2.35. (tr-auth)

27689 PHASE EQUILIBRIA IN THE SYSTEM Y_2O_3–Fe_2O_3–Ga_2O_3. Drys, M.; Trzebiatowski, W. (Inst. of Low Temperature and Structural Research, Wroclaw). Rocz. Chem., 42: 203-10(1968). (In Polish).

Phase relations in the system Y_2O_3–Fe_2O_3–Ga_2O_3 in air including the binary system Y_2O_3–Ga_2O_3 were established using quenching and x-ray powder techniques. In the binary system the existence of two compounds: $3Y_2O_3 \cdot 5Ga_2O_3$ (YGaG) and $3Y_2O_3 \cdot Ga_2O_3$ was confirmed. YGaG melted congruently at 1800 ± 15°C. The 3:1 compound decomposed at its melting point (1770 ± 15°C) into Y_2O_3 and a liquid. YGaG formed solid solutions with Y_2O_3 extending between 47.0 and 58.0 ± 0.2 wt % Ga_2O_3 at 1400°C. The eutectic compositions and temperatures were found to be: 38 wt % Ga_2O_3 at 1740 ± 15°C for 3:1 compound, garnet + liquid and 83 wt % Ga_2O_3 at 1630 ± 10°C for garnet, gallia + liquid. For the ternary system Y_2O_3–Fe_2O_3–Ga_2O_3 phase equilibrium relations at 1350° and at fusion temperatures were established. No ternary compounds or ternary eutectics were observed in this system. (auth)

27690 POLAROGRAPHIC STUDY OF THE RARE EARTH ELEMENTS OF THE YTTRIUM GROUP AGAINST THE BACKGROUND OF THE MELTED EUTECTIC MIXTURE LiCl–KCl. Panchenko, I. D.; Penkalo, I. I. Ukr. Khim. Zh., 34: 42-7 (1968). (In Russian).

The polarographic behavior of the chlorides of Gd, Tb, Dy, Ho, Er, Tm, Yb, and Y against the background of the molten eutectic LiCl–KCl was investigated in an inert atmosphere at 400°C using a rotating electrode. The dependence between the size of the limiting diffusion current and the concentration of the depolarizer was established. The limiting diffusion current was determined. The diffusion coefficients of the ions were calculated, amounting to the order of magnitude of 10^{-6} cm^2/sec. The thinness of the diffusion layer in the molten eutectic mixture was determined. It was found that the potential difference between some rare earth elements can be used for the electrolytic separation of these elements.(tr-auth)

27691 PYROPHOSPHATES OF THORIUM AND URANIUM(IV). Merkusheva, S. A.; Skorik, N. A.; Kumok, V. N.; Serebrennikov, V. V. Radiokhimiya, 9: 723-5(1967). (In Russian).

The solubility of the pyrophosphates of Th and U(IV) in solutions of (H,Na)ClO_4 was studied at 25 ± 0.05°C and ion strength of 0.1. From the solubility data, the sizes of the stability constants and the solubility products were calculated for the pyrophosphates of Th and U(IV). (tr-auth)

27692 QUESTION OF THE EXISTENCE OF UOF_2. Vdovenko, V. M.; Romanov, G. A.; Solntseva, L. V. Radiokhimiya, 9: 727-9 (1967). (In Russian).

A compound with the composition UOF_2 and its crystal hydrate $UOF_2 \cdot H_2O$ were produced. Thermograms were made and the infrared spectra and the proton magnetic resonance spectra were investigated. (tr-auth)

27693 ISOTOPIC EXCHANGE REACTIONS BETWEEN SELENOCYANIDES. NOTE V. EXCHANGE OF LIGANDS IN TETRAHEDRAL COMPLEXES OF Co(II) AND Hg(II) WITH $SeCN^-$. Schiavon, Gaetano; Paradisi, Carmen (Univ., Bologna. Univ., Padua. CNR, Padua. CNR, Bologna). Ric. Sci., 37: 952-5 (Nov. 1967). (In Italian).

The ions SCN^- and $SeCN^-$ in tetrahedral complexes of Co(II) and Hg(II) were compared by means of exchange reactions of labelled ligands. Only $Hg(SeCN)_4^{2-}$ showed a measurable exchange rate. The order and the activation energy of this reaction were determined and a possible mechanism proposed. (auth)

27694 METHOD FOR THE PREPARATION AND ANALYSIS OF SAMPLES OF RARE EARTH AND OTHER METALS WITH SPECIAL PROPERTIES. Gladkikh, A. N.; Skudnov, V. A.; Sokolov, L. D. (Gorky Polytechnic Inst., USSR). Zavod. Lab., 34: 218-21(1968). (In Russian).

New procedures, equipment, and technology for the preparation and analysis of samples of rare earth and other metals were described. A series of original methods for the compression of metals difficult to deform and for the mechanics of the analysis under conditions of low and high temperature were proposed. Tabulated data are given on the characteristics of Tl, Ga, In, Cd, Bi, La, Nd, Pr, Y, Sc, Ho, Er, Tb, Lu, and Co. (J.S.R.)

27695 STUDIES OF TRUE HEAT CAPACITY OF RARE EARTH CHALCOGENIDES (Nd_2Te_3) AT LOW TEMPERATURES. III. TRUE HEAT CAPACITY AT LOW TEMPERATURES, ENTROPY, AND ENTHALPHY OF Nd_2Te_3. Paukov, I. E.; Nogteva, V. V.; Yarembash, E. I. Zh. Fiz. Khim., 42: 998-1000(Apr. 1968). (In Russian).

The true heat capacity of Nd_2Te_3 was measured in an adiabatic vacuum colorimeter at 12.0 to 300°K. The absolute entropy $S^0_{298.15}$ and the enthalpy differences ($H^0_{298.15}$ to H^0_0) were measured under standard conditions. A sudden change in the heat capacity was observed at ~199°K which must be related to the structural changes in the material. The abnormality in the curve $C_p(T)$ in the temperature range from 26 to 28°K was assumed to be the result of magnetic transformation in Nd_2Te_3. (tr-auth)

27696 HEAVY WATER PLANT. Le Chatelier, J. Bull. Inform. Sci. Tech. (Paris), No. 123, 21-5(Feb. 1968). (In French).

The Commissariat a l'Energie Atomique, the Houilleres du Bassin du Nord et du Pas-de-Calais, the Air Liquide, and the Compagnie de Construction Mecanique Procedes Sulzer, were able, within the frame-work of a new type of association to perfect a new process for the production of heavy water, with the accent on the realization of a 100-tons/year plant. Particular attention is given to some of the technical problems that show the similarity that can exist between the pilot plant at Mazingarbe and the final plant. (auth)

27697 HEAVY WATER PLANT AT MAZINGARBE. Lefrancois, Bernard. Bull. Inform. Sci. Tech. (Paris), No. 123, 11-20 (Feb. 1968). (In French).

Studies and tests that led to the industrialization of the ammonia-hydrogen process are described. After the main problems raised by the connection between a heavy water unit and an ammonia synthesis are recounted, a brief description of the Mazingarbe plant is given. (auth)

27698 ISOTOPIC EXCHANGE OF DEUTERIUM BETWEEN AMMONIA AND HYDROGEN: A NEW PROCESS FOR THE PREPARATION OF HEAVY WATER. Roth, E. Bull. Inform. Sci. Tech. (Paris), No. 123, 3-10(Feb. 1968). (In French).

A research effort including laboratory and industrial development aimed at the establishment of a competitive method of operation of heavy water is described. Deuterium extraction from hydrogen present in the ammonia synthesis was chosen. Such a process should enable some countries to prepare the heavy water required for their industrial or scientific needs, without having to build large-capacity plants. Highly industrialized countries might produce considerable amounts of heavy water by building deuterium extraction shops in the required number of ammonia plants. (auth)

27699 TRITIUM EXCHANGE FROM COMPOUNDS IN DILUTE AQUEOUS SOLUTIONS. Waterfield, W. R.; Spanner, J. A.; Stanford, F. G. (United Kingdom Atomic Energy Authority, Amersham, Eng.). Nature (London), 218: 472-3(May 4, 1968).

Some studies on tritium exchange in purines and other "nucleics" and amino acids are reported, under the essentially neutral conditions usually preferred for biological investigations. The samples were autoclaved at 121°C, to simulate the sterilization required when such solutions are to be stored for prolonged periods. It was found that, in general, tritium attached to aliphatic C-atoms was stable, except where enolisation could occur. The same applied to aromatic C-atoms, unless the aromatic ring contained electron donating substituents. Similar results were also obtained under acidic conditions. Tritium in the pyrimidine 6-position was stable, but less so in the 5-position. The rates of loss of tritium from uracil-5-T and uridine-5T were about equal, except that under strongly acid conditions uracil-5-T exchanged five times as fast as uridine. It was confirmed that the C_8 proton in purines is readily exchangeable, as expected in a desmotropic molecule. It is noted that decomposition of T-labeled compounds as a result of self-radiolysis may give products containing readily exchangeable tritium. (UK) (England)

27700 INFRARED INTENSITIES OF THE STRETCHING AND LIBRATIONAL BANDS OF H_2O, D_2O, AND HDO IN SOLIDS. Ikawa, Shun-ichi; Maeda, Shiro (Tokyo Inst. of Tech.). Spectrochim. Acta, Part A, 24: 655-65(May 1968).

Absolute infrared intensities were measured in polycrystalline solid films deposited on the surface of a cold AgCl plate from the vapor. The stretching intensity was about thirty times that of the vapor value for H_2O, and considerably higher than corresponding liquid data in general. The derivative $\partial\mu/\partial r$ was found to be 4.0 D/A for all species. It was also suggested, based on the data for HDO, that the direction of $\partial\mu/\partial r$ is appreciably off the OH(OD) bond axis in a similar way as in the vapor. The librational intensities gave an effective molecular dipole moment of roughly 1.3 to 1.5 D (corresponding to alternative assignments of the bands). This is considerably smaller than normally expected for crystalline molecules, considering the electrostatic induction from surroundings. The latter contribution, however, is thought to be much less effective for the librational intensity, and the above smaller value may be attributable to the change transfer through hydrogen bonds. (auth) (UK)

27701 VERIFICATION OF THE FULFILLMENT OF THE BOUNDARY CONDITIONS IN THE ISOTOPIC EXCHANGE METHOD. Soldatov, E. A.; Kryukov, S. N. (Moscow Univ.). Vestn. Mosk. Univ., Ser. II. Khim., No. 3, 103-4(May-June 1967). (In Russian).

Comparison of the theoretical and experimental data concerning the distribution of the acceptors was used as the criterion for ascertaining the fulfillment of the boundary conditions in the isotope exchange method. The acceptor and donor used were subjected to a diffusion annealing treatment. The acceptor consisted of 99.99% pure silver; the donor silver was labeled with the radioactive ^{100m}Ag. The depth distribution of the labeled atoms was determined by removing the layers electrolytically and calculating the concentration from activity measurements. The isothermic soaking technique was used for obtaining the evaporation and diffusion coefficients. Satisfactory agreement was noted between the theoretical and experimental values, confirming that the boundary conditions were fulfilled. (TTT)

27702 KINETIC STUDIES ON THE REACTIONS OF 2- AND 4-ALKYL-SUBSTITUTED HETEROAROMATIC N-OXIDES WITH ACETIC ANHYDRIDE. Oae, S.; Tamagaki, S.; Negoro, T.; Ogino, K.; Kozuka, S. (Osaka City Univ.). Tetrahedron Lett., No. 8, 917-22(Feb. 1968).

The over-all reaction rates of the compounds were followed spectrometrically for both the deuterated and undeuterated compounds. Most of the reactions followed the second-order rate equation: $v = k_{obs}$ [N-oxide] × [Ac_2O]. A large kinetic isotope effect was noted and would indicate that the rate-determining step of the reaction is the deprotonation step by the acetate anion and that the succeeding steps are fast. (B.L.M.)

27703 INTERACTION OF HYDROGEN WITH SCANDIUM AND Ti-Sc ALLOYS. Grushina, V. V.; Rodin, A. M. Zh. Fiz. Khim., 42: 466-71(Feb. 1968). (In Russian).

The interaction of hydrogen with Sc and Ti–Sc alloys was investigated. It was found that the amount of hydrogen absorbed by the Sc depends on the purity of the Sc. The amount of absorbed hydro-

gen increased with the increase of the purity of the Sc. The thermal stability of the compounds of Sc with hydrogen was significantly higher than in H–Ti and H–Zr, both under conditions of closed space and under conditions of continuous evaporation. The thermal stability of H–Sc structures increased with the increase of the degree of purity of the Sc. The behavior of the alloys of Ti–Sc during their interaction with hydrogen conform with the general laws observed for two-metal alloys on the absorption of hydrogen. With the increase of the content of Sc, the solubility of the hydrogen, expressed in cm^3 of gas per g of metal, increased somewhat, and the quantity of hydrogen atoms, arriving at 1 atom of metal, remained unchanged (1.92 to 1.93) as in pure Sc and Ti. The thermal stability of the compounds of Ti–Sc–H alloys improved with the increase of the content of Sc in the alloy both under conditions of confined space and under conditions of continuous evaporation. The absorption of hydrogen at room temperature with distilled Sc and its alloys with Ti was not observed. (tr-auth)

27704 CALCULATED EMF OF GALVANIC CELLS CONTAINING A SINGLE SOLID OR MOLTEN OXIDE ELECTROLYTE. Gaur, H. C.; Sethi, R. S. (Univ. of Delhi). Indian J. Chem., 5: 485-96(Oct. 1967).

Standard electromotive forces (E°) for reversible galvanic cells of the type, metal/metal oxide/oxygen, involving 136 oxides, in the temperature range 25 to 2000°C, have been calculated from the thermodynamic data. The oxides are arranged in a decreasing order of E° values at 25°C. An attempt has been made to compare the available experimental values for the galvanic cells containing fused and solid metal oxides and values obtained from measurements of decomposition potentials with the calculated values. (auth)

27705 URANIUM COMPLEX WITH PONGAMOL. Atchayya, M. (National Chemical Lab., Poona). Indian J. Chem., 5: 520-1(Oct. 1967).

A uranium(VI) complex of pongamol (5-benzoylacetyl-4-methoxybenzofuran) containing 3 moles of the ligand has been isolated. Thermogravimetric, absorption spectral, and magnetic susceptibility data have been recorded for the complex. (auth)

27706 FORMATION OF HYDRATED COMPLEXES STARTING WITH URANIUM(IV) AND (V) FLUORIDES AND THE HYDRATED DIFLUORIDES OF COBALT, NICKEL, AND COPPER. Montoloy, Francois; Maraval, Simone; Capestan, Michel (CEN, Saclay, France. Faculte des Sciences, Clermont-Ferrand, France). Compt. Rend., Ser. C, 787-9(Mar. 11, 1968). (In French).

In the course of a more general study of the reactions between fluorides of divalent metals and the fluorides of uranium, a study was undertaken of the reactions of UF_4 and UF_5 with $CoF_2 \cdot 4H_2O$, $NiF_2 \cdot 4H_2O$, and $CuF_2 \cdot 2H_2O$ in hydrofluoric acid medium. The complexes corresponding to the following formulas were obtained: $MU_2F_{10} \cdot 8H_2O$ and $MU_2F_{12} \cdot 4H_2O$. (tr-auth)

27707 CHEMISTRY AND PHYSICS OF CARBON. VOLUME 1. Walker, Philip L. Jr. (ed.). A Series of Advances. New York, Marcel Dekker, Inc., 1965. 382p. $14.75.

Information is included on the following topics: dislocations and stacking faults in graphite; gaseous mass transport within graphite; microscopic studies of graphite oxidation; reactions of carbon with carbon dioxide and steam; the formation of carbon from gases; and oxygen chemisorption effects on graphite thermoelectric power. (P.C.H.)

27708 ACID-CATALYZED DEUTERIUM EXCHANGE IN CYCLOPROPYL ACETONE. Sachs, William H.; Rappe, Christoffer (Univ. of Uppsala). Tetrahedron Lett., No. 19, 2317-20(Mar. 1968).

Evidence is presented to support the suggestion that the degree of interaction between the cyclopropyl group and centers of positive charge character is greatly dependent on the charge situation of the center. Since acid-catalyzed deuterium exchange in ketones proceeds via the same mechanism as bromination, which has been postulated to have a transition state close to enol in geometry, relative rates of deuterium exchange at the methyl and methylene groups in cyclopropyl acetone should be a direct indication of the stabilizing effect of the cyclopropyl group in the 3-enol when contrasted with a similar ratio for the isopropyl analog, 4-methyl-2-pentanone. Results show an energy of stabilization of ca 0.7 kcal/mole. This is intermediate to fluorophenylcyclopropane (zero) and the interaction of cyclopropyl group with a carbonyl carbon (as manifested in the observed barrier to rotation in cyclopropyl carboxyaldehyde of >2.5 kcal/mole). (D.H.M.)

27709 DESORPTION OF RARE EARTH ELEMENTS FROM A TUNGSTEN SURFACE. Alekseev, N. I. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Tekh. Fiz., 37: 2224-8(Dec. 1967). (In Russian).

The author has employed the interrupted atomic beam method of S. V. Starodubtsev (ZhETF, 19, No. 3, 215, 1949) to measure the lifetimes of adsorbed La, Nd, Sm, Eu, Tb, Dy, Ho, Er, and Tm atoms on a hot polycrystalline tungsten surface. The measurements were undertaken because surface ionization data in the literature for alkali metals, alkali halides, and rare earth elements are not always in accordance with the Saha-Langmuir equation, and it was thought that in the case of the rare earths the discrepancies might be due to long lifetimes of the adsorbed atoms on the adsorbing surface. An adsorbtion lifetime of 1 millisec was found for each of the investigated elements at different temperatures ranging from about 2000°K for Eu to about 2700°K for La. The temperature dependences of the absorption lifetimes were exponential and corresponded to desorption energies ranging from 3.4 eV for Eu to 6.3 eV for La. The measured desorption energies were found to be in rather good agreement with values calculated from data in the literature by the method of J. D. Levine and E. P. Giftopoulos (Surface Science, 1: 171 (1964)). (ATD).

27710 ISOTOPIC EFFECT ON MIGRATION OF ^{22}Na AND ^{24}Na IONS IN MOLTEN NITRATES; INFLUENCE OF TEMPERATURE AND COMPOSITION. Wuhl, Simon; Lantelme, Frederic; Chemla, Marius (Faculte des Sciences, Orsay, France). J. Chim. Phys., 65: 486-91(Mar. 1968). (In French).

Systematic electromigration experiments of ^{22}Na and ^{24}Na ions were carried out by the asbestos strip method in various systems of molten alkali nitrates. At 350°C the observed isotopic effects are respectively 0.58×10^{-2}, 0.70×10^{-2}, and 0.88×10^{-2} in pure $LiNO_3$, $NaNO_3$, and KNO_3. These variations are in good agreement with the model of polyionic movement and can be attributed to the isotopic exchange equilibrium between free ions and associated species. (auth)

27711 KINETIC SOLVENT ISOTOPE EFFECT IN AROMATIC NUCLEOPHILIC SUBSTITUTION. Bellobono, I. R.; Beltrame, P.; Cattania, M. G.; Simonetta, M. (Univ., Milan). Tetrahedron Lett., No. 22, 2673-6(Apr. 1968).

In connection with an interest in nucleophilic substitutions at aromatic and ethylenic centers a comparative study was made of kinetic solvent isotope effects (KSIE) for hydroxylic solvents in such reactions. Ethanol and ethanol-O-d were chosen as solvents, ethoxide ion and pyridine as nucleophiles, and 2,4-dinitrochlorobenzene as substrate. Rate constants are tabulated. KSIE, as given by k_{EtOD}/k_{EtOH}, was 1.84 for ethoxide ion reactions at 25°C, and 1.30 for pyridine reactions at 90°C. Results are discussed from the theoretical aspect. (UK)

27712 ISOTOPE EFFECTS. II. FURTHER COMMENTS ON THE CONTRIBUTION OF NON-BONDED INTERACTIONS TO SECONDARY DEUTERIUM ISOTOPE EFFECTS. Karabatsos, G. J.; Papaioannou, C. G. (Michigan State Univ., East Lansing). Tetrahedron Lett., No. 22, 2629-31(Apr. 1968).

It was concluded (Karabatsos, et al., J. Amer. Chem. Soc. 89: 463(1967)) that reasonable estimates of secondary deuterium isotope effects caused by non-bonded interactions may be obtained by using Bartell's procedure (J. Amer. Chem. Soc. 83: 3567 (1961)). Some discrepancies were, however, observed between experimental and calculated values. These discrepancies are discussed, and it is stated that in order to draw more reliable conclusions the calculated effect should be compared to that part of the experimental effect due to enthalpy rather than free energy differences. Some solvolysis and hydrolysis studies of 8-methyl-1-naphthoyl chloride and the methyl ester of 8-methyl-1-naphthoic acid are described, with regard to temperature dependence. It was concluded that some secondary deuterium isotope effects might be strongly temperature dependent, and that measurements at a single temperature should be treated with caution. (UK)

27713 ESTIMATION OF U–O BOND DISTANCE IN URANYL COMPOUNDS FROM THEIR INFRARED SPECTRA. Ohwada, Ken (Japan Atomic Energy Research Inst., Ibaraki). Spectrochim. Acta, Part A, 24: 595-9(May 1968).

An equation for the bending frequency (ν_2) of the uranyl ion $\{2\pi^2C^2\nu_2^2 = [(m_U + 2m_O)/m_U]\ (1/m_O) \cdot (K_\delta/R_{U-O}^2)\}$ was applied to determine directly the uranyl U–O bond distance R_{U-O}(Å) in a range of compounds. It was found that the U–O bond distances in the uranyl compounds calculated from this equation, in which the bending force constant K_δ (dyn.Å²/cm) was approximated to the form $A\nu_2^2 + B$(A = 1.66, B = -0.167×10^5) using the well known data on $K_3UO_2F_5$, $NaUO_2(C_2H_3O_2)_3$, and $K_2UO_2O_2$, were in good agreement with the experimental data on some uranyl compounds. (auth) (UK)

27714 ISOTOPIC EXCHANGE REACTIONS STUDIED BY ELECTRODEPOSITION ON THE EVALUATION OF RATE DATA. Beronius, Per (Univ., Umea, Sweden). Z. Phys. Chem. (Frankfurt), 57: 138-44(Feb. 1968).

When the electrodeposition method is employed to investigate isotopic exchange reactions, a stepwise decrease in the concentration of one reactant is caused by the analyses. This error should be corrected for when highly precise rate data are required. A second order rate equation is derived which takes account of this effect. (auth)

27715 INTERACTION OF BENZAMIDEOXIME WITH URANYL IONS. Busev, A. I.; Zholondkovskaya, T. N.; Krysina, L. S.; Korobkina, L. I. (Moscow Univ.). Vestn. Mosk. Univ., Ser. II. Khim., No. 3, 108-10(May-June 1967).

Following up the characteristic reactions of reagents containing the amide oxime $-C\begin{matrix}NOH\\NH_2\end{matrix}$ group, the reaction of uranyl ions with benzamidoxime, $C_6H_5-C\begin{matrix}NOH\\NH_2\end{matrix}$, was investigated spectrophotometrically. Addition of the alcoholic solution of the oxime to the 1 mg/ml aqueous uranyl nitrate solution caused a reddish-brown coloration which disappeared at pH < 4. At pH > 7 the compound decomposed, forming a uranate precipitate. The compound was found to be soluble in ethanol but could not be prepared in the solid state and could not be extracted by solvents. The absorption spectrum revealed an unsharp maximum within the $\lambda = 360$ to 400 mμ range, within which the absorption of the reagent is zero. The required pH value was adjusted by buffer solutions, the optimum range was between pH 5.5 and 7.0. A twentyfold excess was required to obtain the strongest coloration. The reaction may be applied for the spectrophotometric determination of the UO^{2+} ion in alkali and alkaline earth metals, Al, Ga, In, Tl, Sc, rare earth elements, Zn, Cd, Mn, Pb, U(IV), chloride, sulfate, and acetate ions, Th, and Bi. On the other hand, the presence of fluoride, phosphate, Cu, Fe, V, and Cr ions interfere with the determination; citrate, tartrate, and oxalate ions may be tolerated in concentrations of <0.01M. (TTT)

27716 CRYSTAL DATA OF SOME URANYL COMPLEXES. Graziani, Rodolfo; Zarli, Bruno; Bandoli, Giuliano (Univ., Padua. CNR, Padua). Ric. Sci., 37: 984-5(Nov. 1967).

Crystal data are given for the uranyl complexes: $UO_2(OOCCH_3)_2 \cdot (C_6H_5)_3PO$; $UO_2(OOCCH_3)_2 \cdot 2(C_6H_5)_3PO$; $UO_2(NO_3)_2 \cdot 2(C_6H_5)_3PO$; and $UO_2(NO_3)_2 \cdot 2(C_6H_5)_3AsO$. Space groups and cell constants were determined by oscillation, precession, and Weissenberg photographs. Densities were measured by the flotation method using mixtures of sym-tetrabromoethane and sym-dichloroethane. (P.C.H.)

27717 SLOW PROTON TRANSFERS IN AROMATIC NITRATION. Myhre, Philip C.; Beug, Michael; James, Linda L. (Harvey Mudd Coll., Claremont, Calif.). J. Amer. Chem. Soc., 90: 2105-15(Apr. 10, 1968).

The products resulting from nitration and the kinetic isotope effects in the nitrodeprotonation of a series of 1-X-2,4,6-tri-t-butylbenzenes (X = H, F, NO_2, CH_3) were investigated. A variation in the over-all kinetic isotope effect (k_H/k_D) ranging from 1.0 to 3.8 was observed as X is varied from H through CH_3. This variation can be correlated with the increasing size of the substituent X. The results were consistent with the two-step mechanism of aromatic nitration and provided the first evidence that aromatic nitrations can proceed with a rate-limiting proton transfer. (auth)

27718 GROWTH OF MONOCRYSTALS OF URANIUM PHOSPHIDES AND URANIUM ARSENIDES BY CHEMICAL TRANSPORT METHOD. Henkie, Zygmunt (Inst. of Low Temperature and Structural Research, Wroclaw). Rocz. Chem., 42: 363-7(1968). (In Polish).

Application of the chemical transport method for obtaining monocrystals of U_3P_4, UP_2, and U_3As_4 is described. Data on conditions of their growth and morphology are also presented. (auth)

27719 ELIMINATION REACTIONS OF 3-PENTYL HALIDES. RELATIVE DEUTERIUM ISOTOPE EFFECTS FOR CIS-AND TRANS- PENT-2-ENE FORMATION. Griffith, D. L.; Singerman, B. (Case Western Reserve Univ., Cleveland). Chem. Commun., No. 8, 438(1968).

Two apparently conflicting theories exist to explain the product ratios for reactions of bases with 2-halogenoalkanes, one based on steric requirements and the other on the concept of a variable transition state, and it has become apparent that both steric and electronic factors may, under appropriate conditions, exert important directive effects. In order to assess the relationship between these effects in controlling the products of elimination, a study was made of cis- and trans- pent-2-enes obtained from 3-pentyl and [2,2,4,4-$^2H_4$]-3-pentyl halides. For these halides elimination by potassium t-butoxide in t-butyl alcohol gave a higher trans-/cis-pent-2-ene ratio from the deuterated halides, indicating that in this base-solvent system the isotope effect for cis-formation is greater than that for trans-formation. With potassium ethoxide in ethanol the opposite effect was found. The magnitude of the isotope effect was also considerably altered by the nature of the halogen, thus Cl > Br > I. These results are discussed. (UK)

27720 SORPTION OF RADIORUTHENIUM IN COLLOIDAL AND IONIC STATE ON FERROUS HYDROXIDE FORMED BY ELECTRODISSOLUTION OF IRON ANODE. Kepak, F.; Kanka, J. (Nuclear Research Inst., Prague). Int. J. Appl. Radiat. Isotop., 19: 485-7(May 1968).

Ferrous hydroxide shows a high sorption efficiency for radioruthenium. The sorption of ruthenium(III) and nitrosylruthenium-(II) ions, that had partly passed into the colloidal state, was studied on ferrous hydroxide prepared by electrodissolution of an iron anode. Ruthenium and nitrosylruthenium in both the ionic and colloidal states were sorbed with high efficiency on ferrous hydroxide prepared in this way. The hydroxide prepared by this method was more effective than that prepared in the usual way by precipitation. When multistage precipitation was applied, a higher sorption effect was reached than in one stage precipitation. Also, prolongation of the sorbent-precipitation time favorably affected the effectivity of sorption. (auth) (UK)

27721 INTERACTIONS BETWEEN ZIRCONIUM TETRACHLORIDE AND METALLIC ZIRCONIUM. Troyanov, S. I.; Tsirel'nikov, V. I.; Komissarova, L. N.; Spitsyn, Vikt. I. At. Energ. (USSR), 24: 52-6(Jan. 1968). (In Russian).

Interaction in the system $Zr-ZrCl_4$ was investigated by thermographic and tensiometric methods. Temperature for initiation of the reaction was 240 to 250°C. For mixtures with the ratio $Zr : ZrCl_4 = 10 : 3$, the temperature interval for the formation and decomposition of the tri- and dichlorides of Zr was found. Complete decomposition of the dichloride into metal tetrachloride was observed at the temperature of 600°C and pressure of 610 mm Hg. Kinetics of the reaction for the formation and decomposition of the dichloride and zirconium were investigated at the temperatures of 484 and 596°C, respectively. (tr-auth)

27722 THE DIELECTRIC PROPERTIES OF HYDROGEN SULFIDE, HYDROGEN IODIDE, DEUTERIUM IODIDE, DEUTERIUM BROMIDE IN THE CONDENSED PHASES. Havriliak, Stephen Jr. Providence, Brown Univ., 1958. 184p.

Thesis.

The dielectric properties of condensed phases of H_2S, HI, DI, and DBr were studied to better understand crystals composed of simple molecules. The serious errors caused by sample inhomogeneity were minimized by a special cell design, which is a modification and improvement of earlier designs developed in this laboratory by Swenson and others. The changes made resulted in larger and more positive sample compression to prevent void formation, and made preparation of reproducible solid samples possible in about three quarters of the attempts. Equilibrium dielectric constants were measured from the boiling points to temperatures as low as 60°K. Phase transitions indicated by discontinuities were in agreement with those deduced from specific heat data in all cases. The values for the liquid and high-temperature solid phases varied linearly with reciprocal absolute temperature and agreed reasonably well with the Onsager theory. Dispersion phenomena were observed in the frequency range 20 c/s to 500 Kc/s for the intermediate temperature solid phases of the two iodides and the bromide. Much of these dispersions can be described by the simple Debye expression. The logarithms of the relaxation times vary linearly with reciprocal temperature, with slopes corresponding to activation energies of a few kcal/mole. Abnormally large but reproducible dielectric constants (as high as 200) were observed at the low temperature phase transitions. In the iodides shorter relaxation times were observed below the transition, contrary to simple expectations, and the character of the dispersion changed from Debye behavior to a depressed circular arc complex dielectric constant locus. Two dispersion regions, both of circular arc type, were observed in DBr; most of the change in polarization occurs in the lower frequency process, and the higher is approximately 1000 times faster. Dipole-dipole interaction energy calculations were made for the two ordered structures of hydrogen halides proposed by D. F. Horning and co-workers from infrared evidence. One of these, in which alternate oppositely directed chains of dipoles lie in staggered rather than coincident lines in projection, is found to have low dipole energy, which suggests the importance of dipole forces in determining the structure. Other factors, such as quadrupole and induced dipole forces, are probably also significant, as discussed in the thesis, but no very definite conclusions are yet possible. (Diss. Abstr.)

27723 CONVERSION OF HEAT TO ELECTRICITY BY ELECTROCHEMICAL MEANS USING UO_3 MELT. McKenzie,

Donald E.; Howe, John P. (to North American Rockwell Corp.). U. S. Patent 3,368,921. June 17, 1960.

A method for the conversion of heat to electricity by electrochemical means comprises providing a melt of UO_3 in an alkali metal phosphate salt electrolyte, heating the solution to a temperature sufficient to decompose the UO_3 to U_3O_8 and O_2, separating the resulting U_3O_8 melt and O_2 gas, and separately introducing the cooled U_3O_8 and O_2 gas decomposition products into an electrolytic cell having an alkali metal phosphate electrolyte. The U_3O_8 melt is introduced into the anode compartment, and the O_2 is introduced into a separate cathode compartment. UO_3 is reformed in the cell at the anode and electrons are donated to an external load. The reformed UO_3 is removed, heated, and returned to the cycle. (USAEC)

27724 TRANSITION STATE OF BASE-CATALYZED SILICON–OXYGEN BOND CLEAVAGE. Latham, Kenyon Stuart Jr. Lawrence, Kan., Univ. of Kansas, 1967. 148p.

Thesis.

To more thoroughly examine the nature of the catalytic action and the structure of the rate-limiting transition state, the base-catalyzed solvolysis in hydroxylic solvents of phenoxytriphenylsilanes was undertaken. The kinetic rate equation and associated rate constants for the methanolysis of five phenoxytriphenylsilanes— $Ph_3SiOC_6H_4X$, with X = H, p-MeO, p-Me, p-Cl, m-CF_3— in basic acetate and phenoxide buffer solutions were determined. The p-chloro compound was also studied in acetate-buffered methanol-d_1 to determine the solvent isotope effect. The acidity constants of the buffer components and of the parent phenols of the reactant leaving groups were determined, the latter constants for use in interpretive structure-reactivity discussions. The base-catalyzed methanolysis reaction obeys the kinetic rate law: Rate = $\{k_O + k_{OMe}[OMe^-] + k_B[Base]\}$ [Silane]. Increased electron-withdrawal by aromatic substituents on the phenoxy leaving group results in an increased rate of reaction. The Hammett ρ value is ca. +3.5 to +5.0, but there is pronounced curvature, concave-upward, in the plot. A better correlation is obtained between the pK_a of the leaving-group phenol and the methanolysis rate constants, though some curvature is still present. No deuterium isotope effect was observed in methanol-d_1; k_H/k_D was about 1.3. Application of the Brønsted catalysis law gives a β value of 0.7, with the substituent variations causing little change in its magnitude; the rate constant for phenoxide catalysis is greater than predicted, possibly because of the involvement of π-complexation. The methanolysis of phenoxytriphenylsilanes was found subject to general base catalysis, proceeding via a proton-transfer mechanism. Deuterium isotope effects indicate that Si–O bonding change is the ratelimiting factor and not proton transfer. The mechanism most consistent with experimental results involves proton extraction from an attacking solvent molecule, thereby increasing its nucleophilicity. Either intermediate formation of an unstable pentavalent Si species or a concerted S_N2-type mechanism with possible Si 3d-orbital participation could be involved; a distinction between these two possibilities is not possible at present with the available information. Deviations in structure-reactivity correlations can be explained by either the presence of rate enhancing $d_\pi - p_\pi$ interactions or polarizability effects. (Diss. Abstr.)

27725 SOME SOLUTION CHEMISTRY OF RADON. Haseltine, Marcus Walter Jr. Manhattan, Kan., Kansas State Univ., 1967. 108p.

Thesis.

Some solution chemistry of ^{222}Rn, the radioactive daughter of ^{226}Ra, was studied. Solutions of 10^{-7}M radium bromide were allowed to remain in contact with various aqueous, oxidizing solutions for a period of 23 days (six half-lives of Rn) or longer. These solutions were then extracted with equal amounts of hexane. The relative amounts of Rn in the two phases were determined by counting the 0.35-MeV γ activity of a subsequent daughter, ^{214}Pb. The samples were counted after a 2-hr aging period. The distribution ratios of Rn between hexane and the various aqueous solutions were then calculated and the results used as a measure of the extent of oxidation. These ratios indicated a change from elemental Rn, which is very soluble in hexane (distribution ratio 33), to an oxidized species of Rn, which was much less soluble in the organic phase (distribution ratio 0.2). This apparent oxidation of Rn was substantiated with gas flushing experiments. Ion exchange column experiments, using Dowex 50 cation exchange resin and Dowex 1 anion exchange resin, were performed with elemental Rn and with the oxidized Rn species in solutions of differing pH. Oxidized Rn in solutions that had been made strongly alkaline with NH_4OH (trials at pH 11.6, 11.8, and 12.5) was retained on the anion exchange column. Elution was not accomplished with water or Cl^-, but the Rn was removed by elution with NO_3^-. Oxidized Rn in a neutral or acidic solution, when passed through the anion exchange column, was eluted with water. The same was found for oxidized Rn, regardless of acidic or basic conditions when passed through the cation exchange resin. Elemental Rn, produced from Ra decay in water, was not retained on either the cation or anion exchange resin regardless of the pH of the Rn solution. Thus, oxidized Rn appeared to be non-ionic in a neutral or acidic solution and to be a negative ion in a strongly alkaline solution. If Rn behaves like Xe, the oxidized Rn species could be RnO_3 below a pH of 11.8 and $HRnO_4^-$ in a more alkaline solution. Batch ion exchange experiments were used to estimate the equilibrium constant for the equation "RnO_3" + $H_2O \rightleftharpoons$ "$HRnO_4^-$" + H^+. Oxidized Rn solutions of varying pH were shaken for four minutes with 0.2 g of Dowex 1 anion exchange resin. At the end of the shaking period, the resin was separated from the solution by pouring the resulting slurry through a column fitted with a glass wool plug. The relative amounts of Rn on the resin and in solution were determined in the previously described manner. Using parameters obtained from a plot of the data resulting from these batch experiments, an estimate of the equilibrium constant was made. The constant was estimated to be 2.6×10^{-12}. This ion exchange method for equilibrium constant determination was then tested with ^{77}As in the form of carrier-free arsenous acid. The experimental value obtained (5.2×10^{-10}) was in good agreement with the recorded literature value (6×10^{-10}) of the equilibrium constant for the equation $H_3AsO_3 \rightleftharpoons H_2AsO_3^- + H^+$. (Diss. Abstr.)

27726 SURFACE STUDIES IN THE VAPOR-SOLID SYSTEM BORON TRIIODIDE–TUNGSTEN. Ownby, Paul Darrell. Columbus, Ohio State Univ., 1967. 165p.

Thesis.

Adsorption and nucleation of BI_3 on W by physical vapor deposition and of B from BI_3 on W by chemical vapor deposition were studied. The solid vapor pressure of BI_3 was calculated to follow $\log P_{mm} = (-3610/T) - 2.517 \log T + 17.894$. The surface tension of BI_3 liquid under its own vapor was determined by capillary rise in vacuo to be $\sigma l_v = -0.0926T + 66.5$. Time-of-flight mass spectrometry showed that no dimers or polymers of BI_3 existed in the vapor phase. The contact angle of BI_3 on tungsten approached zero by the sessile-drop technique in vacuo. Evidence for thermal nonaccommodation of BI_3 on Pyrex was presented; however, from supersaturation data, thermal accommodation of BI_3 on W was calculated. The physical vapor deposition of BI_3 on macroscopic W substrate was studied using a Volmer-type apparatus. The nucleation of BI_3 on W was preceded by multilayer adsorption. The critical concentration of adsorbed monomers required for nucleation was 1.0×10^{15} molecules/cm^2. Adsorption was time dependent at low temperatures. A steady state between impingent and desorption fluxes occurred at temperatures of ≈160 K. The following Gibbs free energies were determined: for formation of the critical nucleus, 1700 cal/mole; for surface-diffusion activation, 1900 cal/mole; for desorption activation, 11,700 cal/mole; and the critical volume free-energy change, −72 cal/cm^3. Weaknesses in the theory and alternative approaches are discussed. Boron deposits were obtained at higher substrate temperatures and analyzed. Both amorphous and crystalline B were found. The crystalline B appeared to be a monotropic, nonequilibrium form. Mechanisms for these phases were suggested and the thickness of each approximated. Because of reflection from the glass walls of the apparatus, deposits were found on both sides of the foil substrates. Deposit thicknesses were in agreement with those calculated from impingent flux and time considerations. Techniques were developed for adapting high vapor-pressure sources to the field-emission microscope for observing adsorption and nucleation in their earliest stages at high resolution on clean single-crystal surfaces. The details of B adsorption from the chemical vapor deposition process were observed. Smoothing of the [100] and [233] planes resulted in attenuation of the emission from these areas. This produced the characteristic pattern of B on W suggested by Young. During a deposition run, a buildup of B on the periphery of the [110] and [211] planes created a bright double cross effect from the consequent enhanced emission. At lower substrate temperatures in the chemical vapor deposition range and with modest impingent fluxes, a B buildup around and, eventually, virtually over the [110] plane resulted in a uniquely intense and centrally concentrated field-emission pattern. Large single crystals of nonepitaxial B were observed on the W tip. Smaller B crystals could be produced at higher fluxes and these were also apparently not related epitaxially to the substrate. (Diss. Abstr.)

27727 SURFACE CHEMISTRY OF THORIA GEL. Olsen, Charles Stanley. Salt Lake City, Univ. of Utah, 1967. 128p.

Thesis.

A surface study of thoria gel based on results of an insitu infrared technique indicated six possible forms of surface water, two forms were adsorbed as molecular water and four as sur-

face hydroxyl groups. One of the two forms of molecular water was physically adsorbed and easily removed while the other was strongly bonded, possibly to surface nitrates. Of the four types of surface hydroxyl groups indicated, one appeared to be non-hydrogen bonded, two were unique and appeared as rather monochromatic states, and the fourth form apparently involved hydrogen bonding with surface nitrates. Infrared evidence also indicated covalently bonded surface carbonate probably due to CO_2 adsorption from the atmosphere during the preparation of thoria gel. On heating thoria to 300°C under vacuum, the thoria gel turned from a white color to completely black. This discoloration was attributed to a defect state in thorium oxide. However, it may be due to residual carbon formed by decomposition of surface carbonates. A strong interplay between the strongly bound physical water and the nitrate in the gel was also found. The physical water was used to explain anomalies in the thorium nitrate infrared spectrum. Spectral assignments were verified by controlled surface reactions with H_2O, D_2O, and CO_2. The lattice structure of thorium oxide was considered on the (111), (110), and (100) planes to explain the various surface species adsorbed. Hydrogen bonding was first considered on the lattice planes. However, the best explanation was on the basis of adsorption primarily on the (111) planes by a coordination model. (Diss. Abstr.)

27728 HYDROGEN ATOM ADDITION TO OLEFIN MOLECULES AT CRYOGENIC TEMPERATURES. Kelley, Richard David. Washington, D. C., Catholic Univ. of America, 1967. 99p.

Thesis.

A technique was developed by which hydrogen atom addition to olefin molecules can be studied in great detail. The hydrogen atoms, generated on a hot filament, were allowed to impinge on a film of olefin condensed at cryogenic temperatures (below 150°K). It is shown unequivocally that the addition reaction takes place at the surface, and does not occur in the bulk of the film. The surface concentration of the olefin is replenished by diffusion from the interior of the film. The alkyl radicals formed at the surface either diffuse into the interior and are depleted solely by reaction with other radicals, or remain on the surface long enough to react with hydrogen atoms. Since the fate of the radical is dependent on diffusion conditions in the matrix, it was possible to isolate for detailed study the disproportionation and combination reactions of alkyl radicals with alkyl radicals and with hydrogen atoms. The disproportionation to combination ratio k_d/k_c for alkyl radicals was measured at 90°K. The k_d/k_c ratio for isopropyl radicals is 6, and that for s-butyl is 11. These results indicate that the activation energy for combination exceeds that of disproportionation by several hundred cal/mole. The activation energy for the addition reaction, H + C_3H_6, was found to be 1000 cal/mole, while that for addition of H to 2-methyl-2-butene is 1300 cal/mole. The orientation of the H atom addition to a number of unsymmetrical olefins has been determined at 90°K. The temperature coefficient for the orientation was found to be quite small. An usual isotope effect was also observed in the orientation of H, D, and T atom addition to C_3H_6. It is difficult to reconcile these findings with the current theory of such effects. (Diss. Abstr.)

27729 CHEMISTRY AND PHYSICS OF CARBON. VOLUME 2. Walker, Philip L. Jr. (ed.). A Series of Advances. New York, Marcel Dekker, Inc., 1965. 383p. $15.50.

Information is included on the following topics: electron microscopy of reactivity changes near lattice defects in graphite; porous structure and adsorption properties of active carbons; radiation damage in graphite; adsorption from solution by graphite surfaces; electronic transport in pyrolytic graphite and boron alloys of pyrolytic graphite; and activated diffusion of gases in molecular-sieve materials. (P.C.H.)

27730 CHEMISTRY AND PHYSICS OF CARBON. VOLUME 3. Walker, Philip L. Jr. (ed.). A Series of Advances. New York, Marcel Dekker, Inc., 1968. 449p. $22.75.

Information is included on the following topics: nonbasal dislocations in graphite; optical studies of carbon; action of oxygen and carbon dioxide above 100 millibars on pure carbon; x-ray studies of carbon; and carbon transport studies for helium-cooled high-temperature nuclear reactors. (P.C.H.)

27731 PURIFICATION OF CARBON DIOXIDE. Platt, Brian Stanley; Halford, Peter (to Petrocarbon Developments Ltd.). British Patent 1,110,829. Apr. 24, 1968. Filed Nov. 29, 1965.

Carbon dioxide containing hydrocarbons as impurities is purified by distillation at a temperature below 15°C at a superatmospheric pressure to remove the impurities as an overhead gaseous fraction and recover the purified CO_2 as a liquid bottom fraction. The refrigeration for maintaining the required low temperature and for condensing vapors from the head of the column to provide reflux is produced by an external refrigeration cycle. The heat for the distillation is provided partly by cooling of the feed stream of impure CO_2 before it enters the distillation column and partly by the cooling and condensation of at least part of the compressed refrigerant. (B.L.M.)

27732 SHAFT FURNACE FOR THE BURNING OF GRAPHITE. Decate, Pierre; Faugeras, Pierre; Huneau, Rene (to Commissariat a l'Energie Atomique). British Patent 1,111,164. Apr. 24, 1968. Priority date Apr. 6, 1965, France.

A shaft furnace is described for the burning of graphite for recovery of metals, such as U and Pu, incorporated in the graphite. The furnace consists of a vertical cylindrical chamber provided with graphite loading means, means for the supply of a combustion supporting gas, and means for discharging the combustion gases through a granular mass to retain the entrained solid particles. The granular mass occupies the base of a sealed tank into which the bottom open part of the chamber penetrates and is embedded in the granular mass so that it supports the graphite to be burned. The combustion temperature is automatically controlled by introduction of varying amounts of combustion gas into the granular material. (B.L.M.)

27733 METHOD OF PREPARATION OF AMMONIUM PHOSPHOTUNGSTATE AND PRODUCT OBTAINED. Aubertin, Charles; Lefevre, Jean; Poupard, Michel; Raggenbass, Andre (to Commissariat a l'Energie Atomique). British Patent 1,110,951. Apr. 24, 1968. Priority date Aug. 19, 1964, France.

A method is described for the preparation of ammonium phosphotungstate having mechanical properties to render it suitable for use as a cation exchanger. Ammonium phosphotungstate is precipitated from an organic solution of phosphotungstic acid by the addition of NH_3. The solid is filtered, washed, and dried. The mechanical strength of the washed precipitate is improved by a heat treatment consisting of maintaining a temperature of at least 360°C for a period of at least 15 hr. The preferred solvent is acetone, but other solvents capable of dissolving both the acid and NH_3 are also suitable. (B.L.M.)

27734 ELECTROLYTIC SEPARATION OF TRANSITION METAL OXIDE CRYSTALS. Kunnmann, W.; Ferretti, A.; Arnott, R. J.; Rogers, D. B. (to United States Atomic Energy Commission). U. S. Patent 3,382,161. May 7, 1968.

A method of producing large crystals of transition metal oxides comprises melting a mixture of 10 mole % transition metal oxide and flux (sodium tungstate–sodium pyrotungstate) and precipitating the crystals out of the mixture. These large crystals are useful in the microwave field. (AEC)

27735 TEMPERATURE DEPENDENCES OF ISOTOPE EFFECTS. Stern, Marvin J. (Yeshiva Univ., New York); Spindel, W.; Monse, E. U. Contracts AT(30-1)-3462; AT(30-1)-3663. J. Chem. Phys., 48: 2908-19(Apr. 1, 1968). (TID-23989).

It is shown that the harmonic-vibrational contributions to an isotope effect can by themselves lead to several types of temperature-dependence "anomalies," including inflections, maxima, minima, and "cross-overs," in a plot of the logarithm of an isotopic equilibrium-constant or rate-constant ratio vs temperature (or vs logarithm of temperature). In a series of calculations for a large number of ^{15}N and ^{18}O isotope-exchange equilibria among fourteen simple oxynitrogen compounds, such "anomalies" were found in 15 of the 91 ^{15}N exchanges considered and in 97 of the 153 ^{18}O exchanges considered. The significance of the prevalence of temperature-dependence "anomalies" to equilibrium and kinetic isotope-effect studies is discussed. (auth)

27736 URANIUM(IV)-(VI) ELECTRON EXCHANGE REACTIONS IN ANION EXCHANGE RESIN, TRI-n-OCTYL AMINE AND TRI-BUTYL PHOSPHATE. Gonda, Kozo (Power Reactor and Nuclear Fuel Development Corp., Tokyo); Kawashima, Nobuyoshi; Kakihana, Hidetake. J. Nucl. Sci. Technol. (Tokyo)., 5: 179-86 (Apr. 1968).

A study was made of the U(IV)–U(VI) electron exchange reactions taking place between natural U(IV) and depleted U(VI) in anion exchange resin, as well as in TnOA–benzene and TBP–benzene systems. The exchange rate in the anion exchange resin was smaller than the corresponding rates in 8 to 10M HCl, which might be explained by considering that the diffusion of the exchangeable species is much slower in the anion exchange resin than in 8 to 10M HCl. The exchange rates in TnOA–benzene and in TBP–benzene were accelerated by decreasing the concentration of TnOA or TBP in benzene. The reason may be that TnOA and TBP, including the exchangeable species, is more easily diffused in dilute than in concentrated solution. Based on activation energy values, the mechanism of exchange in the anion exchange resin was estimated to be similar to that in 8 to 10M HCl solution, and the corresponding mechanism for TBP–benzene similar to that for the cation exchange resin. In the case of TnOA–benzene, the exchange process

was presumed to resemble that of the anion exchange resin, judging from the similarity of ionic species extracted thereinto. (auth)

27737 ROLE OF THE INFLUENCE OF SOLVENTS IN THE MECHANISM OF IODINE EXCHANGE. Koeroesi, E. Thesis.

Detailed studies were performed on the isotope exchange reaction between elementary iodine and 1-phenyl-2,3-dimethyl-4-iodopyrazolone (IAp), indexed as 4-iodoantipyrine, by using different solvents. With the aid of kinetic measurements it was established that in carbon disulfide, benzene, and aliphatic alcohols the following equation may be derived to illustrate the rate of the exchange: $v = k_2[IAp][I_2]^2 + k_3[IAp][I_2]^3$. In water the rate of exchange is determined by the following equation: $v = k_1[IAp][I_2] + k_2[IAp][I_2]^2$. The Laidler-Eyring equation is valid for the investigated reactions as well; a linearity exists between the constant of the rate of the exchange reaction and the correlation $(D - 1)/(2D + 1)$ where D = dielectric constant. Some extrathermodynamic correlations were investigated and it was found among others that the theory of compensation $(\Delta H_1^* - T\Delta S_1^* + \Delta H_2^* - T\Delta S_1^*)$ is valid for the different solvents. The thermodynamic data, the effect of the dielectric constant, the undefinable effect of oxygen and light, the interactions between solvent and reacting materials and the probable mechanism of the exchange reaction in various solvents were determined by considering the results of the kinetic measurements. The role of the solvent in activated complex formation, the importance of the association pre-equilibrium of iodine and the structure of activated complexes are discussed. It was found that the mechanism of the exchange reaction between IAp and elementary iodine differed from that of the iodine exchange reactions existing between elementary iodine and other iodine compounds. Actually reactions between IAp and iodine may be considered as a process catalyzed by iodine molecules because linking of the iodine molecules to the active centers of IAp by donor-acceptor interaction decreases the strength of the C—I bond thus diminishing the activating free energy of the reaction as well. This type of reaction is named "charge-transfer autocatalysis." The exchange reactions between elementary iodine and organic iodine compounds were interpreted on the basis of this theory. (Hung. Tech. Abstr.)

27738 EUROPIUM. Sinha, Shyama P. Anorganische und allgemeine Chemie in Einzeldarstellungen, Herausgegeben von Margot Becke-Goehring. Band VIII. New York, Springer-Verlag New York Inc., 1967. 170p. $9.75.

Information is included on the following topics: methods of separation of individual rare earth elements; preparation and properties of Eu; alloys and intermetallic compounds of Eu; compounds of Eu, including inorganic coordination and organic coordination; spectroscopic properties of Eu, including absorption spectra of the Eu ion and its complexes and the luminescence spectra of the Eu ion in different environments; and possible uses and applications of Eu. A subject index and 679 references are appended. (P.C.H.)

27739 INTRODUCTION TO MAGNETOCHEMISTRY. Earnshaw, A. London, Academic Press, 1968. 125p. 37s. 6d.

The subject is treated under the following main headings: introduction; free atoms and ions; transition metal complexes; crystal field theory; further topics (antiferromagnetism, spin free-spin paired equilibria); and experimental. (U.K.)

27740 LA CHIMICA DELL'ACQUA NEI REATTORI NUCLEARI: SIMPOSIO, ROMA, 20–22 MAGGIO 1963. (Symposium on Water Chemistry in Nuclear Reactors, Rome, May 20–22, 1963). Rome, Comitato Nazionale Energia Nucleare, 1966. 296p. (CONF-213).

Ten papers and abstracts of two more papers presented at the symposium are included. Separate abstracts were prepared for 7 of the papers; the remaining 3 were previously abstracted for NSA. For abstract numbers of the individual papers see CONF-213 in the Report Number Index. (M.C.G.)

For abstracts of individual papers see: 27768, 27769, 27871, 27872, 28741, 29743, and 30176.

Radiation and Nuclear Chemistry

Refer also to abstracts 27699, 27740, 28110, 28735, 29291, 29800, and 30155.

27741 (BNL–12361) CURRENT PROBLEMS IN THE CHEMICAL EFFECTS OF NUCLEAR TRANSFORMATIONS. Harbottle, Garman (Brookhaven National Lab., Upton, N. Y.). [1967]. 23p. (CONF-680423–2). Dep. CFSTI.

From 2nd Inter-American Conference on Radiochemistry, Mexico City, Mex.

Research in hot-atom chemistry is reviewed and some suggested that can be attacked in radiochemistry laboratories having limited facilities. Topics covered include: chemical effects of isomeric decay in liquid organic halides and comparison with the (n,γ) reaction, mechanisms governing the recoil chemistry of hot atoms in complex ion crystals, specific problems in annealing reactions of recoil atoms in crystals, dilute solution studies, noble gas chemistry in recoil reactions, and hot atom effects in nature with natural radioactive isotopes. (111 references). (M.C.G.)

27742 (BNL–12405) MEDICAL RADIONUCLIDE DEVELOPMENT PROGRAM. Richards, P.; Stang, L. G. Jr. (Brookhaven National Lab., Upton, N. Y.). Apr. 12, 1968. 18p. Dep. CFSTI.

Research is reported on: the development of a new ^{28}Mg preparation process, the improvement of ^{99m}Tc-labeled compounds and complexes, the preparation and evaluation of ^{123m}Te for potential medical applications, and preliminary studies of the separation of short- and ultrashort-lived isotopes for evaluation as biological tracers. (M.C.G.)

27743 (CONF-680423–1) RADIATION CHEMISTRY OF ORGANIC GLASSES. Grimison, Alec (Puerto Rico Nuclear Center, San Juan). [1968]. Contract AT(40-1)-1833. 13p. Dep. CFSTI.

From 2nd Inter-American Conference on Radiochemistry, Mexico City, Mex.

Some of the important considerations in the radiation chemistry of low-temperature organic glasses are reviewed, and some specific results obtained at the Puerto Rico Nuclear Center are presented. The main emphasis is on the matrix isolation technique. The major work at PRNC has centered around the use of two particular glassy matrices for the spectrophotometric identification of gamma-radiolytic intermediates from simple heterocyclic molecules. These are 2-methyltetrahydrofuran (MTHF) and a mixture of two commercial Freons (FM). It was concluded that the matrix isolation method provides a very effective way of studying the intermediates produced by gamma radiolysis. (P.C.H.)

27744 (NYO–3242–25) EXCITATION AND IONIZATION BY IONIZING RADIATIONS IN WATER AND AQUEOUS SOLUTIONS. Stein, Gabriel (Hebrew Univ., Jerusalem (Israel). Dept. of Physical Chemistry). Dep. 1967. Contract AT(30-1)-3242. 16p. (CONF-671212–2). Dep. CFSTI.

From 19th Farkas Memorial Symposium, Jerusalem, Israel.

The evidence for excitation of water and aqueous solutions by ionizing radiations was surveyed. Light emission studies on aqueous systems were critically examined. Compared with many liquid organic systems, in liquid aqueous systems light emission and, in general, excited state formation, is low. Light emission originates from the lowest singlet excited states. In frozen aqueous systems total excited state formation and light emission increases and triplet states preponderate. The various mechanisms responsible for the observations: direct excitation; chemiluminescence from excited states resulting from radical addition processes; triplet formation from charge recombination; and quenching of excited states by radioinduced radicals were surveyed. (auth)

27745 (PRNC–88) MATRIX ISOLATION STUDIES OF PRODUCTS OF GAMMA-RADIOLYSIS OF HETEROCYCLIC MOLECULES. Progress Report No. 1, Fiscal Year 1966. Grimison, Alec (Puerto Rico Nuclear Center, San Juan). Contract AT(40-1)-1833. 20p. Dep. CFSTI.

Two main designs of optical dewars have been tested for the examination of optical spectra at liquid nitrogen temperatures. Both designs are described. Preliminary qualitative results were obtained by γ irradiation of a wide variety of heterocyclic molecules in tetrahydromethylfuran (MTHF) and 3-methylpentane (3-MeP) glassy solutions at 77°K. Color formation was examined visually, both at 77°K, and that emitted on slight warming. Data are tabulated. The theoretical work completed was divided into two sections because of the different approaches used: the valence-bond technique, and the molecular-orbital technique. The valence-bond calculations refer to the singlet, triplet, and quadruplet states of cyclobutadiene as a model for later work on pyrrole, furan, etc. In the molecular orbital work, calculations have been carried out on a series of heterocyclic and neutral molecules, using the omega-technique, which is an iterative scheme based on the Hueckel approach. (P.C.H.)

27746 PREPARATIVE AND KINETIC ASPECTS OF THE γ-RADIATION-CHEMICAL FORMATION OF PHOSPHONIUM AND OTHER ONIUM SALTS. Caspari, G.; Drawe, H. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Z. Naturforsch., 22b: 570-2(June 1967). (In German).

Quarternary phosphonium salts were formed during the γ-irradiation of mixtures of triphenylphosphine (TPP) or tributylphosphine with aryl halides. The rate of conversion was markedly increased upon dilution of the mixtures with hydrocarbon solvents

such as benzene, cyclohexane, and cyclohexene. An ionic mechanism is discussed in which a positive charge transfer from the solvent to TPP and dissociative electron capture by the aryl halide are involved. Several phosphonium salts were synthesized. Arsonium salts were produced from triphenylarsin-arylhalide-mixtures with G-values about ten times lower than in the corresponding TPP reactions. The yield of stibonium salts was still lower. Trialkylamines reacted with aryl halides to give trialkyl or dialkyl ammonium salts. The rate of conversion can also be drastically increased by the addition of benzene. (auth)

27747 STUDIES ON POLYMER BLENDS. II. BUTADIENE–STYRENE COPOLYMERS AND POLYBUTADIENE–POLYSTYRENE BLENDS. Shundo, Minoru (Sakai Chemical Industrial Co., Ltd., Kobe, Japan); Hidaka, Takashi; Goto, Kunio; Imoto, Monoru; Minoura, Yuji. J. Appl. Polymer Sci., 12: 975-89(May 1968).

The properties of butadiene–styrene copolymers and of polybutadiene–polystyrene blends were compared. Polybutadiene, polystyrene, and four copolymers having styrene contents of 20, 40, 60, and 80% were prepared. The copolymers were compared with blends having various styrene contents and prepared by means of latex blending and roll blending. Vulcanizates were prepared by three different curing methods, i.e., sulfur cure, peroxide cure, and radiation cure. The results of the benzene extraction of three vulcanizates showed that the polystyrene blended was not cured by any of the curing methods used. The properties of the vulcanizates of the copolymers were markedly different from those of the blends, i.e., in the case of the blends the properties showed a linear relationship with their blending ratio, while in the copolymers the properties showed a curvilinear relationship that had an inflection point at a styrene content of about 60%. From this phenomenon of the copolymers, it was proposed that the second-order transition point of styrene is the cause of the properties showing this peculiar point. From the results, it was found that the behavior of styrene in copolymers is essentially different from that in blends. (auth)

27748 EFFECT OF NUCLEAR REACTIONS AND RADIOACTIVE TRANSFORMATIONS ON THE CAVITATION THRESHOLD. Gorodenko, P. G.; Obraztsov, V. I.; Filatov, E. S. (Univ., Moscow). Dokl. Akad. Nauk SSSR, 177: 629-32(Nov. 1967). (In Russian).

The voltage on the quartz converter of an ultrasonic unit at the first visible appearance of bubbles was taken as a measure of the cavitation threshold in a liquid. Propyl bromide was irradiated with 10^7 neutrons/sec from a Po–Be source and the cavitation threshold increased linearly from 1.6 to 2.7 kV on varying the distance from the neutron source to the focal region over the limits of 3.5 to 11.5 cm. No change in cavitation threshold could be observed on placing a paraffin screen 8 cm thick between the source and propyl bromide. In studying the effect of nuclear decay reactions, the propyl bromide was irradiated with slow neutrons for periods of 2, 4, 8, 18, 43, and 120 hr. Radioactive bromine isotopes were formed with half-lives of 6 min, 18 min, 4.5 hr, and 36 hr. The cavitation threshold depended on irradiation time and decay time after irradiation. The radioactive decay event with a half-life of 4 to 5 hours had an effect on the cavitation threshold. (TTT)

27749 REACTION OF GASES WITH IRRADIATED ORGANIC SOLIDS. NOTE I: PRELIMINARY RESULTS ON PROPIONAMIDE, n-BUTYRAMIDE AND ISOBUTYRAMIDE. Faucitano, Antonio; Perotti, Angelo; Adler, George (Brookhaven National Lab., Upton, N. Y.). Ric. Sci., 37: 1149-55(Dec. 1967).

Preliminary results of an EPR study of the reactions of oxygen and sulfur dioxide with the radicals induced by γ-irradiation in propionamide, n-butyramide, and isobutyramide are reported. The gases diffuse into the crystals of the amides reacting with the radicals. The result is a reaction which is controlled by the rate of diffusion and the crystalline structure of the host compound. A reaction mechanism is proposed to explain the results. (auth)

27750 CHEMISTRY OF ORGANIC FLUORINE COMPOUNDS. III. ADDITION OF ETHANOL AND ACETALDEHYDE TO TRIFLUOROCHLOROETHYLENE. Liska, F.; Dedek, V.; Chutny, B. (Inst. of Chemical Tech., Prague. Inst. for Nuclear Research, Rez, Czech.). Collect. Czech. Chem. Commun., 33: 1299-1306 (Apr. 1968).

The reaction of ethanol with trifluorochloroethylene catalyzed by di-tert-butylperoxide or by azo-bis-isobutyronitrile yielded, together with addition or telomeric products i.e., 3,3,4-trifluoro-4-chloro-2-butanol (II), 3,3,4,5,5,6-hexafluoro-4,6-dichloro-2-hexanol (III) and 3,3,4,5,5,6,7,7,8-nonafluoro-4,6,8-trichloro-2-octanol (IV), also 3,3,4,5,5,6-hexafluoro-4,6-dichloro-2-hexanone (VIII). After initiation of the reaction by γ irradiation, the reaction products contained, together with the secondary alcohols II, III, and IV and with the ketone VIII, also appreciable amounts of a tertiary alcohol which was identified by NMR and ir spectra as 3-methyl-1,2,2,4,4,5,6,6,7-nonafluoro-1,5,7-trichloro-3-heptanol (V). The mechanism of formation of these products is discussed. The γ-irradiation-initiated addition of acetaldehyde to trifluorochloroethylene yielded 3,3,4-trifluoro-4-chloro-2-butanone (VII), 3,3,4,5,5,6-hexafluoro-4,6-dichloro-2-hexanone (VIII) and 3,3,4,5,5,6,7,7,8-nonafluoro-4,6,8-trichloro-2-octanone (IX) which were obtained also by oxidation of secondary alcohols II, III, and IV with chromic mixture. (auth)

27751 EFFECT OF X-RAYS ON EXTENDED CHAIN CRYSTALS OF POLYOXYMETHYLENE. Jaffe, M.; Wunderlich, B. (Rensselaer Polytech. Inst., Troy, N. Y.). J. Polym. Sci., Part A-2, 6: 825-31(May 1968).

Extended chain crystals of polyoxymethylene were irradiated with x rays of about 10^5 R/min. An immediate decrease in superheating on melting was noted. After 90 min of irradiation the melting point level, refractive indices, and density also decreased. After 480 min the DTA melting peak at a heating rate of 20°C/min had decreased 25°C, the melting point decreased about 18°C, and the density calculated from refractive indices decreased 0.031 g/cm^{-3}. These effects are interpreted as indication of chain scission and formation of amorphous defects. (auth)

27752 GRAFT-POLYMERIZATION OF STYRENE ON POLYETHYLENE SINGLE CRYSTALS. Iguchi, Masatoshi; Koyama, Yukihiko; Tonami, Hiroaki; Kawai, Toru (Tokyo Inst. of Tech.). Makromol. Chem., 111: 74-92(Feb. 12, 1968).

The graft polymerization of styrene through use of γ-irradiation was carried out in vapor phase onto polyethylene single crystals, bulk films of polyethylene, and paraffine crystals. It was found that the grafting yield for a given dosage was much less for polyethylene single crystals than for bulk films. The similar difference was also found between the pure paraffine (n-tetracosane) and mixed paraffines, and these results were interpreted in the light of crystallinity. In order to characterize the polystyrene branches grafted onto the crystals, a new method based on chain transfer reaction was proposed for obtaining number of the grafted points and the length of the branches and was applied to the graft polymerization onto the polyethylene single crystals. The results were compared with those obtained for the graft polymerization onto paraffine crystals. In the latter case, molecular weight of the graft polymer obtained after extracting paraffines from the whole material could be obtained by assuming the copolymer as polystyrene homopolymer. In both of the cases the polymer branch was very long and the sites of grafting were very few. The crystallinities of the samples measured by an x-ray diffraction method before and after the grafting showed that the grafting did not practically affect the original crystals. The surfaces of the grafted crystals were also examined by an electron microscope and the result implied that the reaction took place mainly on the surfaces of the crystals. (auth)

27753 RADIOACTIVE MANGANESE PENTACARBONYL RADICALS IN NEUTRON IRRADIATED MANGANESE CARBONYL COMPOUNDS. de Jong, I. G.; Wiles, D. R. (Carleton Univ., Ottawa). Chem. Commun., No. 9, 519-20(May 8, 1968).

There is evidence to suggest that radical reactions are important in Szilard–Chalmers processes in manganese carbonyl compounds, not only in regard to the re-formation of the parent compound, but also in the formation of other compounds. It was found that neutron irradiation of benzene solutions of dimanganese decacarbonyl gives rise to phenyl-manganese pentacarbonyl. This and other observations with these compounds suggest that the $Mn(CO)_5$ radical is a major participant in these reactions, in both the liquid and the solid state. The studies described involved irradiation of the target compound, dissolution in an appropriate solvent, and addition of carriers for the desired compounds, followed by separation of the carriers by column chromatography on silica gel. Radioactive $Mn_2(CO)_{10}$ was detected in neutron irradiated (cp) $Mn(CO)_3$ and Me (cp) $Mn(CO)_3$, suggesting in both cases combination of two $Mn(CO)_5$ radicals. Also, on dissolving neutron irradiated $Mn_2(CO)_{10}$ in pentane solutions of iodine, ^{56}Mn-labeled IMn $(CO)_5$ was detected. The yield appeared to vary with some aspect of the experimental conditions. With neutron irradiated (cp) $Mn(CO)_3$, $IMn(CO)_5$ was also produced at the time of dissolution. It was concluded that the $Mn(CO)_5$ radical was present in the solid matrix until released at the dissolving interface, at which time it was scavenged by the iodine. A reaction mechanism is proposed. (UK)

27754 GAMMA RADIOLYSIS OF LIQUID DECAHYDRONAPHTHALENE. Stachowicz, Waclaw; Kecki, Zbigniew; Minc, Stefan (Inst. of Nuclear Research, Warsaw). Nukleonika, 13: 187-99 (1968).

Radiolytic yields and composition of hydrogen, volatile hydrocarbons, and high boiling products as well as their chemical structures in the gamma radiolysis of decahydronaphthalene were determined using gas chromatography, infrared spectrometry, and ebuliometry. The influence of dose, temperature, and concentration of scavenger (I_2) on radiolytic yields of hydrogen was investigated. On the ground of these data the mechanism of the gamma radiolysis of decahydronaphthalene in liquid state has been proposed. (auth)

27755 PRIMARY ISOTOPE EFFECT FOR THE REPLACEMENT OF H VS. D BY ENERGETIC TRITIUM ATOMS. Smail, Thomas; Rowland, F. S. (Univ. of California, Irvine). J. Phys. Chem., 72: 1845-7(May 1968).

Experiments were made that involved recoil tritium irradiation of various isotopic isobutanes, isolation of the tritium-labeled isobutanes from other radioactive products, and then measurement of the fraction of the tritium in the tertiary position in each molecule. Comparison of the relative yields in tertiary vs primary position for $(CH_3)_3$ CH vs $(CH_3)_3$ CD and for $(CD_3)_3$ CH vs $(CD_3)_3$ CD furnished two separate estimates of the primary replacement isotope effect. Data are presented for both gas and liquid phases. While the data showed a marked phase effect in all samples, all measurements showed a consistent primary replacement isotope effect of ~1.25. (D.H.M.)

27756 RADICAL PRODUCTION BY γ IRRADIATION OF 3-METHYLPENTANE, METHYLTETRAHYDROFURAN, AND METHYLCYCLOHEXANE GLASSES AT 77°K WITH AND WITHOUT ALKYL HALIDE SOLUTES. Shirom, Miriam; Willard, John E. (Univ. of Wisconsin, Madison). Contract AT(11-1)-1715. J. Phys. Chem., 72: 1702-7(May 1968). (COO-1715-139).

The yield of free radicals from the γ irradiation of 3-methylpentane (3MP) at 77°K (G = 1.6) was not changed by photobleaching of the trapped electrons or by the presence of electron scavengers (except as the latter cause H abstraction by hot processes). This indicates that solvent radicals cannot be formed by neutralization of solvent ions by trapped or scavengeable electrons. The G values for radicals produced by the $RX + e^- \rightarrow R + X^-$ reaction from ten organic halides in 3 MP glass increase with increasing halide concentration up to ca. 0.8 mol %, above which they remain constant, at ca. 1.1, indicating that this is the yield of electrons able to escape recombination with the parent ion. Trapped methyl radicals formed by dissociative electron capture by methyl halides in 3 MP glass did not decay by abstracting hydrogen from the solvent. Hot methyl radicals formed by dissociative electron capture by CH_3I in 3MP glass abstracted hydrogen to form CH_4, with $G(CH_4) = 0.3$. $G(C_2H_6)$ for the analogous reaction of ethyl halides in 3MP or MTHF is 0.15. Photobleaching of the intense electron signal produced by γ irradiation of methyltetrahydrofuran (MTHF) glass did not change the concentration of the free radical present in the system. The G values for dissociative electron capture by alkyl halides in MTHF and methylcyclohexane (MCH) glasses increased with alkyl halide concentration to plateau values qualitatively similar to the results in 3MP glass. (auth)

27757 SPECTROPHOTOMETRIC IDENTIFICATION OF γ RADIOLYTIC INTERMEDIATES IN A NEW HALOGENIC GLASSY MATRIX. Grimison, A.; Simpson, G. A. (Puerto Rico Nuclear Center, Rio Piedras. (Univ. of Puerto Rico, Rio Piedras). Contract AT(40-1)-1833. J. Phys. Chem., 72: 1776-9(May 1968).

The absorption spectra, dose dependence, and character of the intermediates produced by γ radiolysis at 77°K of a 50:50 vol % mixture of Freon-11 (CCl_3F) and Freon-114B2 (CF_2BrCF_2Br) were determined. Color centers were formed at 330 and 585 mμ which could be bleached by light of suitable wavelengths and which were assigned to cationic species. The stabilization of other cationic intermediates by this matrix was demonstrated by the detection of intermediates of several heterocyclic additives Identification of the following cations and their λ_{max} was made: thiophene (830, 320 mμ), pyrrole (800 mμ), and pyridine (380 mμ). (auth)

27758 RECOIL-TRITIUM REACTIONS IN THE SOLID PHASE: ABSOLUTE YIELDS AND PHASE EFFECTS. Menzinger, Michael; Wolfgang, Richard (Yale Univ., New Haven. Univ. of Colorado, Boulder). J. Phys. Chem., 72: 1789-92(May 1968).

A method for determining the absolute yields of recoil-tritium reactions in the solid phase is described. First results of this technique confirm that phase effects play only a minor part in hot hydrogen atom reactions, a situation very different from that for hot halogens. It appears that while caging effects are important in halogen atom reactions, they are not usually significant for atomic hydrogen. (auth)

27759 MECHANISM OF RADIATION-INDUCED LUMINESCENCE FROM SCINTILLATORS IN CYCLOHEXANE. Hentz, Robert R.; Knight, Ronald J. (Univ. of Notre Dame, Ind.). J. Phys. Chem., 72: 1783-9(May 1968). (COO-38-582).

The radioinduced luminescence from scintillators (p-terphenyl and 2,5-diphenyl-1,3,4-oxadiazole) was studied in deaerated cyclohexane solutions containing an electron scavenger. The scavengers SF_6, N_2O, CO_2, C_2H_5Br, n-C_3H_7Cl, and benzyl acetate were used. A study also was made of the effect of these solutes and the scintillators on nitrogen yields obtained in radiolysis of cyclohexane solutions of N_2O. Over the concentration ranges studied with γ radiation, the six solutes had no effect on the intensity of luminescence produced by uv excitation of the scintillators. However, all six solutes did quench scintillator luminescence produced by γ irradiation of the cyclohexane solutions and in a manner very similar to the effect of the electron scavengers and scintillators on N_2 yields from the γ-irradiated N_2O solutions. Relative specific rates of electron capture are calculated using a model for radioinduced ionic reactions in liquids of low dielectric constant; values obtained from the luminescence-quenching and N_2O-protection studies are compared. It is concluded that radioinduced scintillator luminescence in cyclohexane is explicable in terms of a sequence of ionic reactions. The scintillator captures electrons and positive charge in competition with recombination of the sibling cation–electron pairs produced in the solvent. Scintillator excitation occurs in the neutralization of a scintillator anion by a solvent or scintillator cation and in the neutralization of a scintillator cation by an electron. (auth)

27760 RADIOLYSIS OF CYCLOHEXANE IN THE PRESENCE OF DEUTERATED OLEFINS. THE INVOLVEMENT OF THE OLEFINS IN HYDROGEN FORMATION. Robinson, M. G.; Freeman, G. R. (Univ. of Alberta, Edmonton). J. Phys. Chem., 72: 1780-2(May 1968).

The hydrogen yields from the radiolysis of cyclohexane solutions containing low concentrations of deuterated olefins (C_3 to C_7) were measured. The presence of significant amounts of HD and D_2 in the products confirms an earlier suggestion that the olefins participate in hydrogen formation as well as acting as inhibitors. However, it is mainly the alkyl groups of the fully deuterated olefins that are involved in HD formation. A small amount of molecular D_2 elimination occurs from the olefinic carbons. The addition of ethanol to a solution of C_2D_6 in cyclohexane reduced the yields of HD and D_2 by the same proportionate amounts. The results are explained by ionic reactions. There was no clear-cut evidence for the occurrence of hydrogen atom scavenging. (auth)

27761 RADIATION CHEMISTRY OF CARBON. VIII. STRUCTURE OF DESOXYGLUCOSE FORMED DURING THE RADIOLYSIS OF α-METHYL-D-GLUCOSIDE AND THE MECHANISM OF ITS FORMATION. Kochetkov, N. K.; Kudryashov, L. I.; Chlenov, M. A. (Inst. of Chemistry of Natural Compounds, Moscow). Zh. Obshch. Khim., 38: 79-85(Jan. 1968). (In Russian).

The structure of one of the principal radiolysis products of α-methyl-D-glucoside, 5-deoxy-4-keto-D-arabino-hexose, was investigated. The formation of desoxyglucose, occurring during the radiolysis of sugars, was first demonstrated. Experimental evidence of the participation of hydrated electrons in the radiolysis process of glucosides was reported. A general radiolysis scheme was proposed for glucosides, including in the first stages the formation of negatively charged molecular ions. (tr-auth)

27762 THE RADIATION-INDUCED COPOLYMERIZATION OF TETRAFLUOROETHYLENE AND 3,3,3-TRIFLUOROPROPENE UNDER PRESSURE. Brown, Daniel W.; Wall, Leo A. (National Bureau of Standards, Washington, D. C.). J. Polym. Sci., Part A-1, 6: 1367-79(May 1968).

A study was made of the γ-induced copolymerization of tetrafluoroethylene and 3,3,3-trifluoropropene. Copolymerizations were carried out at 100°C and 5000 atm pressure and at 21°C and various pressures up to 8000 atm. The reactivity ratios calculated from the composition data indicate that the propagation rate constants favor addition of trifluoropropylene by a factor of 3 to 7; individual values depended little on the polymerization pressure and temperature. Polymerization rates changed little with monomer composition between 0 and 75% tetrafluoroethylene; between 75 and 95% tetrafluoroethylene they increased by a factor of 10. As many as 850,000 molecules were polymerized per 100 eV absorbed. The copolymers were soluble in hexafluorobenzene at 29.6°C if they contained less than 70% tetrafluoroethylene. Intrinsic viscosities range from 0.1 to about 10 dl/g. From various considerations it appears likely that the degree of polymerization is about equal to the kinetic chain length in high-pressure polymerizations at 21°C; at autogenous pressure or at 5000 atm and 100°C, monomer transfer reduces the value considerably. (auth)

27763 ELECTRON SPIN RESONANCE STUDY OF THE RADIATION-INDUCED POLYMERIZATION OF N-VINYLCARBAZOLE. Ayscough, P. B. (Univ. of Leeds, Eng.); Roy, A. K.;

Croce, R. G.; Munari, S. J. Polym. Sci., Part A-1, 6: 1307-13 (May 1968).

When crystals of N-vinylcarbazole were γ-irradiated at 77°K, the ESR spectrum observed before warming consisted of three peaks attributed to a radical-cation with the unpaired spin associated mainly with the nitrogen atom. Above 90°K, polymerization occurred, initiated by the cation, and the spectrum changed to that of an alkyl type of radical, $\equiv N-\dot{C}H-CH_2$, trapped in the polymer. Single crystals were used for a detailed analysis of the nuclear hyperfine parameters of the observed radicals. (auth)

27764 THE INFLUENCE OF GAMMA RADIATION ON THE REACTION KINETICS BETWEEN U_3O_8 AND H_2SO_4 SOLUTIONS. Spitsyn, Vikt. I.; Gromov, V. V.; Medvedev, A. S. (Inst. of Physical Chemistry, Moscow). Dokl. Akad. Nauk SSSR, 178: 397-9(Jan. 11, 1968). (In Russian).

Gamma radiation effects on dissolution of uranium mixed oxide powder (U_3O_8) in dilute sulfuric acid were studied with U_3O_8 powders prepared from uranyl nitrate annealed in the air at 1000°C (with the final product formula $UO_{2.67}$ with lattice parameters a = 6.86 and c = 4.15 Å). Data on the kinetics of dissolution of γ-irradiated mixed uranium oxides in 0.1N H_2SO_4 solution at 20°C showed that doses of less than 10^{18} eV/g did not affect the rate of diffusion, while at doses of 10^{19} to 10^{20} eV/g the rate of uranium transition into the solution was slowed down. It was postulated that the reduced rate of irradiated dissolution of U_3O_8 is caused by the γ-quantum order-disorder transformation of crystalline lattice. (R.V.J.)

27765 RADIATION-INDUCED POLYMERIZATION OF ISOPRENE IN AQUEOUS SOLUTION OF SILVER NITRATE. Fujioka, Syuji (Toyo Rayon Co., Ltd., Otsu, Japan); Ichimura, Tadao; Shinohara, Yasuo; Hayashi, Koichiro. J. Polym. Sci., Part A-1, 6: 1109-20(May 1968).

The rate of radioinduced polymerization of isoprene in aqueous solution of silver nitrate was 20 to 50 times as fast as the rate of radioinduced polymerization of pure isoprene. The formation of a 1:2 complex of isoprene and silver nitrate was confirmed spectrometrically, and this complex seems to polymerize by attack of an active species. The equilibrium constant K_f and the extinction coefficient E of the complex were estimated to be 0.18 and 1.4, respectively. The polymerization mechanism was concluded to be a radical one, based on the effects of inhibitors. The polyisoprene obtained had a crosslinked structure, was insoluble, and did not give a distinct melting point. The 1,2 structure was the predominant polyisoprene configuration. This was interpreted on the basis of the frontier electron density of isoprene. (auth)

27766 RADIATION-INDUCED, SOLID-STATE POLYMERIZATION OF DERIVATIVES OF METHACRYLIC ACID. I. POSTIRRADIATION POLYMERIZATION OF ZINC METHACRYLATE. O'Donnell, J. H.; Sothman, R. D. (Univ. of Queensland, Brisbane). J. Polym. Sci., Part A-1, 6: 1073-86(May 1968).

The postirradiation polymerization of the crystalline, anhydrous, monohydrate, and dihydrate forms of zinc methacrylate was studied. The anhydrous salt polymerized readily in the temperature range 50 to 150°C, the monohydrate did not polymerize at all, and the dihydrate polymerized at about 100°C. Aging of the anhydrous salt greatly affected the rate of polymerization; this was shown to be due mainly to the formation of peroxides by reaction with air. Polymerization could be initiated thermally, without irradiation, in monomer which had been aged in contact with air, apparently by decomposition of the peroxides. The rate of the postirradiation polymerization was increased when air was present during irradiation and decreased when air was present during polymerization. The rate of polymerization increased with temperature, corresponding to an apparent activation energy of 10 kcal/mole. The dihydrate lost one molecule of water rapidly under vacuum at 20°C and slowly on heating at 50°C in a sealed vessel, forming a crystalline monohydrate. Slow thermal polymerization and rapid postirradiation polymerization occurred at 100°C without the formation of any monohydrate, indicating that the polymerization was concurrent with the phase change. (auth)

27767 THE DEGRADATION OF POLY(ETHYLENE TEREPHTHALATE). Buxbaum, L. H. (Goodyear Tire and Rubber Co., Akron, Ohio). Angew. Chem. Int. Ed. Engl., 7: 182-90 (Mar. 1968).

Extensive studies of the nature of the thermal, hydrolytic, oxidative, and radioinduced degradation reactions were reported. The interpretation of kinetic investigations and the identification of the reaction products were facilitated by using suitable esters as model compounds in place of the polymeric species. (auth)

27768 STUDIES OF THE AQUEOUS RADIATION CHEMISTRY OF NITROGEN AND OF THE HOT-ATOM CHEMISTRY OF ^{13}N AND ^{16}N IN AQUEOUS SOLUTION. Hammar, L.; Forsen, S.; Hedlund, S.; Lundqvist, R. (Aktiebolaget Atomenergi, Studsvik, Sweden). pp 79-118 of La Chimica dell'Acqua nei Reattori Nucleari. Rome, Comitato Nazionale Energia Nucleare, 1966.

From Symposium on Water Chemistry in Reactors, Rome. See CONF-213.

Use of ammonia for alkalinity control in water in water-cooled reactors is considered. The radiation chemistry of ammonia and nitrogen and the recoil reactions of ^{13}N and ^{16}N are discussed. Radiolysis of aqueous solutions of ammonia by gamma radiation and neutrons is described. Radioinduced fixation of nitrogen in aqueous solutions was also studied. (M.C.G.)

27769 RECOMBINATION OF RADIOLYTIC GASES DISSOLVED IN WATER ON A FIXED CATALYST BED. Zermizoglou, R.; Randrianarivo, J.; Vignet, P. pp 269-91 of La Chimica dell'Acqua nei Reattori Nucleari. Rome, Comitato Nazionale Energia Nucleare, 1966. (In French).

From Symposium on Water Chemistry in Reactors, Rome. See CONF-213.

Preliminary studies on the recombination of the radiolysis products of heavy water were made in the liquid phase on a fixed catalytic bed, near room temperature. The kinetic study of the catalytic recombination of H_2 (dissolved) + $\frac{1}{2}O_2$ (dissolved) in dynamic regime shows that the recombination of radiolytic gas in the liquid phase is feasible in a simple, inexpensive circuit. (J.S.R.)

27770 PULSE RADIOLYTIC STUDIES OF THE COMPETITION H + H AND H + FERRICYANIDE. THE ABSOLUTE RATE CONSTANTS. Rabani, J. (Hebrew Univ., Jerusalem); Meyerstein, D. J. Phys. Chem., 72: 1599-1603(May 1968).

The bimolecular rate constant of the reaction of hydrogen atoms with ferricyanide ions was measured in aqueous solutions. The value obtained for $k(H + Fe(CN)_6^{3-})$ was $(6.5 \pm 0.5) \times 10^9$ M^{-1} sec^{-1} in the region pH 2 to 3. Competition between $H + Fe(CN)_6^{3-}$ and H + H yielded $2k(H + H) = (2.5 \pm 0.4) \times 10^{10}$ M^{-1} sec^{-1}. (auth)

27771 PULSE RADIOLYSIS OF AMMONIA GAS: RATE OF DISAPPEARANCE OF THE NH $^3\Sigma$ RADICAL. Meaburn, G. M. (Centre d'Etudes Nucleaires, Saclay, France); Gordon, Sheffield. J. Phys. Chem., 72: 1592-8(May 1968).

The radiolysis of ammonia gas at pressures ranging from 300 to 1000 torr was studied using pulse techniques. The absorption spectrum of the NH radical due to the $A^3\pi \rightarrow X^3\Sigma$ transition at 3360 A was obtained and the disappearance of this radical under various experimental conditions was studied by following the decay of this band. The NH radical formed with a G value of ~0.4 and decayed by a second-order process in pure ammonia. An upper limit of 7×10^{11} M^{-1} sec^{-1} for the second-order rate constant for the reaction of two NH radicals was calculated from the data. Scavengers such as O_2, propylene, and ethylene reacted with NH, their relative rate constants being k_{NH+O_2}: k_{NH+Pr}: k_{NH+Eth} = 40:2:1. Ammonia vapor and water vapor (up to 6%) did not react with NH in the triplet ground state. (auth)

27772 RADIATION-INDUCED SOLID-STATE POLYMERIZATION OF DERIVATIVES OF METHACRYLIC ACID. IV. ELECTRON SPIN RESONANCE SPECTRA OF BARIUM METHACRYLATE DIHYDRATE. Bowden, M. J.; O'Donnell, J. H. (Univ. of Queensland, Brisbane). J. Phys. Chem., 72: 1577-82(May 1968).

The ESR spectrum of γ-irradiated barium methacrylate dihydrate at −196°C, attributed to the radical $(CH_3)_2\dot{C}-COO$, was observed to change to the spectrum characteristic of the propagating radical $RCH_2\dot{C}(CH_3)COO^-$ on warming above −100°C. This transformation was temperature and time dependent. The spectrum of the propagating radical after several days at −80°C consisted of 9 lines with hfs of 11.5 G and an increasing intensity distribution. Immediately on warming to 50°C the spectrum was similar, but on cooling back to −80°C an alternating intensity distribution was observed, and further cooling to −154°C resulted in splitting of the intermediate lines; this effect was reversible. When maintained at 50°C, the intensities of the intermediate lines decreased continuously so that the increasing intensity distribution changed to an alternating intensity distribution and finally to a 5-line spectrum. These different spectra are all attributed to the methacrylate propagating radical and are considered to result from different conformations of the β-methylene carbon–hydrogen bonds. The conformation of the radical, and hence the ESR spectrum, is believed to depend on the length of the radical chain, the temperature, and the environment. Various models are considered to explain the changes in conformation. (auth)

27773 RADIOLYSIS OF AQUEOUS SOLUTIONS OF COBALT COMPLEXES. Zevos, Nicholas (Sloan Kettering Inst. for Cancer Research, New York). J. Phys. Chem., 72: 1506-10(May 1968).

The radiolysis of acidic and neutral solutions containing hexa-

amminecobalt(III) perchlorate and tris(ethylenediamine) cobalt(III) perchlorate by ^{60}Co γ rays was investigated. In air-saturated acidic solutions, $G(Co^{2+})$ was 2.3 and 0.31 ions/100 eV for $Co(en)_3(ClO_4)_3$ and $Co(NH_3)_6(ClO_4)_3$, respectively. The radiolysis of $Co(NH_3)_6(ClO_4)_3$ was characterized by an induction period at low doses which was removed by the presence of Co^{2+}. $Co(en)_3(ClO_4)_3$ did not display an induction period under similar conditions. It appears that the ligand of $Co(en)_3^{3+}$ undergoes reaction with the hydroxyl radical directly. In neutral solutions, the central metal atom was reduced to Co^{2+} by hydrated electrons. For air-free solutions, there was a nonlinear increase of the cobaltous ion concentration with absorbed dose; while in air-saturated solutions, there was a linear response with $G(Co^{2+}) = 3.3$ ions/100 eV for $Co(NH_3)_6(ClO_4)_3$ and $G(Co^{2+}) = 2.4$ ions/100 eV for $Co(en)_3(ClO_4)_3$. (auth)

27774 LOW-CONVERSION RADIOLYSIS OF METHANE CONTAINING TRACES OF OXYGEN AND OLEFINS. Myers, D. C.; Schmidt-Bleek, F. (Purdue Univ., Lafayette, Ind.). J. Phys. Chem., 72: 1475-82(May 1968).

Mixtures of CH_4 with 0.1 to 1 vol % of oxygen and mixtures of methane with 0.1 vol % of oxygen and 0.1 vol % of either ethylene-^{14}C, acetylene-^{14}C, or propyne-3-^{14}C were exposed to ^{60}Co γ radiation. The applied doses varied from 10^{-3} to 30×10^{-3} eV/molecule. With oxygen present, $G(C_2H_6) = 0.276$, irrespective of olefinic additives. Hydrogen atoms do not take part in the ethane formation whether oxygen is present or not. With either oxygen or olefins or both present, $G(H_2) = 3.14$. G(H) in methane was tentatively assigned the value of 4 ± 0.3. The minimum dose (eV/molecule) required to remove oxygen radiolytically from methane is $D = [O_2]$ (1.3×10^{-5}), where $[O_2]$ is in parts per million. The radiolytic oxidation of methane leads to CO_2, while acetylene and ethylene are the principal precursors of CO. (auth)

27775 PULSE RADIOLYSIS OF SOLUTIONS OF AMINES OF LOW IONIZATION POTENTIAL. Kemp, T. J. (Univ. of Warwick, Coventry, Eng.); Roberts, J. P.; Salmon, G. A.; Thompson, G. F. J. Phys. Chem., 72: 1464-70(May 1968).

Pulse radiolysis of dilute (~10^{-2} M) solutions of triphenylamine (TPA), N,N,N′,N′-tetramethyl-p-phenylenediamine (TMPD), and N,N-dimethyl-p-phenylenediamine (DMPD) in solvents including aromatic and aliphatic hydrocarbons, certain ethers, benzyl alcohol, and dimethyl sulfoxide (DMSO) produced transient, intense absorptions closely resembling those of the corresponding amine radical cations. In most of the solvents, however, the effects of added second solutes, including electron and positive-ion scavengers, energy acceptors, and paramagnetic materials, indicate that the absorbing species are not positive ions but are triplet states of the amines. In DMSO, however, the converse appears to be the case. (auth)

27776 RADIATION-INDUCED CIS-TRANS ISOMERIZATION OF STILBENES IN LIQUID NAPHTHALENE. Malan, O. G.; Guesten, H.; Schulte-Frohlinde, D. (Kernforschungszentrum, Karlsruhe, Ger.). J. Phys. Chem., 72: 1457-61(May 1968).

The ^{60}Co γ-induced cis–trans isomerization of 4-nitro-4′-methoxystilbene in molten naphthalene as solvent was measured and the dependence on dose, concentration, and additives was studied. The G(trans → cis) was lowered by naphthacene and 4,4′-dimethoxystilbene and enhanced by pyrene as additives. The results could be explained using kinetic equations derived from a proposed reaction scheme involving excitation transfer. Naphthalene was much more efficient in energy transfer than benzene. (auth)

27777 RADIATION CHEMISTRY OF WATER, AQUEOUS SOLUTIONS, AND SIMPLE ORGANIC COMPOUNDS. Minder, Walter (Eidgenoessisches Gesundheitsamt, Bern). Hand. Med. Radiol., 2: Pt. 1, 39-182(1966). (In German).

Topics reviewed and discussed include: radiochemical kinetics, fundamentals of dosimetry, chemical detection procedures (manometry, viscosity measurements, titration, chromatography and electrophoresis, paramagnetic resonance absorption, and mass spectroscopy), radiochemistry of inorganic aqueous systems, primary radiochemical reactions of water, radiation oxidation of $FeSO_4$, radiation chemistry of other aqueous electrolyte solutions, radiation oxidations and reductions, effects of radiations on mixtures, radiochemistry of simple organic compounds, effects of various types of organic molecular binding, wave mechanical models, binding properties of C atoms, bond energies, radiation reactions in the gaseous phase, reactions of hydrocarbons, radiochemical reactions in model organic systems, reactions of organic halogen compounds and other compounds, radiation chemistry of aqueous solutions of simple organic materials and dyes, and organic synthesis induced by irradiation of chemical mixtures. (438 references). (BBB)

27778 THE RELATIVE IMPORTANCE OF THE PRIMARY IONIZATION PROCESSES IN THE γ RADIOLYSIS OF n-PROPANOL. van der Linde, H. J.; Basson, R. A. (Afdeling Chemie, Pretoria). J. S. Afr. Chem. Inst., 20: 149-60(Oct. 1967). (In Afrikaans).

The major products in the γ radiolysis of n-propanol are H_2, propanal, 3,4-hexanediol, formaldehyde, and ethane. The total yield of α-hydroxypropyl radical under conditions used is 4.9; $G(CH_3CH_2CHOH) = G(e) + G_H + G_{H\cdot} + G(CH_3CH_2CH_2OH^+) + G(C_2H_5)$. The important ionizing processes are simple ionization, ionization with loss of α-H and H^+, and ionization with cleavage to give C_2H_5 and CH_2OH. It is found that $G(e) + G_H = 2.5$. Evaluation of formaldehyde formation and its relation to the production of ethyl gives $G(C_2H_5) = 1.4$. Thus $G(CH_3CH_2CH_2OH^+) + G_{H\cdot} = 1.0$. Of these two the contribution of $H^\cdot$ is very close to 1.0 by itself; mass spectral analogies are quoted, and results from the influence of CO and $CrCl_3$ on the production of H_2 from ethanol parallel the effect here in indicating two processes in ethanol. The discussion centers on scavenger effects, material balance, stoichiometric requirements, and a reaction scheme. (BBB)

27779 STABILITY OF RADIATION-INDUCED ORGANIC FREE RADICALS: DECAY BY HEAT. Horan, P. K.; Taylor, W. D.; Strother, G. K.; Snipes, W. (Pennsylvania State Univ., University Park). Biophys. J., 8: 164-74(Feb. 1968). (NYO-3799-5).

Polycrystalline samples of various organic compounds were irradiated in air at room temperature with a ^{60}Co source at a dose rate of 1.07×10^6 R/hr. A 20-mg sample irradiated to a total dose of 10^7 R was placed in EPR tube and evacuated to 0.1 torr to prevent reactions with O_2 on subsequent heating. The EPR measurements were made at X band microwave frequencies. Quantitative measurements of the relative number of spins in samples were made by comparison with a standard sample of pitch in KCl. In this manner the rate of free radical decay was measured at various temperatures. Rate constants determined from first-order decay kinetics were used to determine the activation energy for the process of free radical decay. The similarity between the temperature dependence of free radical decay by heat and that of electrical conductivity led to a consideration of the possibility that the two processes may be related. Mechanisms by which a population of electron-hole conducting states may lead to free radical decay are outlined and experimental data relating to these mechanisms are discussed. (BBB)

27780 COMPARATIVE STUDY OF THE AGING PROCESS OF POLYMER FILMS UNDER THE ACTION OF ULTRAVIOLET AND OF IONIZING IRRADIATIONS. Yanova, L. P.; Maslovskaya, R. S.; Taubman, A. B. Lakokrasoch. Mater. Ikh Primen., No. 2, 66-7 (1967). (In Russian).

A comparative study of the effects of uv and of ionizing radiations on the optical and mechanical properties of films made of perchlorovinyl resin (PSKh-S) was conducted. Lamp PRK-4 ($E_{uv} = 0.93 \times 10^{16}$ eV/cm^3 · sec) and an electron accelerator ($E'_{el} = 2.6 \times 10^{18}$ eV/cm^3 · sec) were used as radiation sources, and times of exposure were taken as $\tau_{uv} = \tau_{el} \cdot 280$ to compensate for the difference in the source radiation intensities. Absorption determinations were made with a SF-4 spectroscope. The films darkened gradually and their absorptions increased in the course of the experiments. The two types of irradiation produced similar effects on the elongation and the ultimate strength of the films. The results obtained suggest that ionizing irradiation may be used as an auxiliary method for studying the aging of polymer films. The relation between temperature and material deformation for nonirradiated and irradiated films was also studied, and the results are shown graphically. (ATD)

27781 MECHANISM UNDERLYING THE ACTION OF THE SECONDARY AROMATIC AMINE TYPE OF ANTIOXIDANTS AND THEIR ETHERS UPON THE RADIATION OXIDATION OF N-BUTYLPROPIONAMIDE AND POLYCAPROAMIDE. Brodskii, A. I.; Fomenko, A. S.; Abramova, T. M.; Dareva, E. P.; Furman, E. G.; Spirina, I. A. (Inst. of Physical Chemistry, Kiev). Dokl. Akad. Nauk SSSR, 179: 370-3(Feb. 21, 1968). (In Russian).

The EPR method was used for determining the mechanism of reactions taking place between radicals produced by radiolysis and radioinduced oxidation of polyamides of N-butylpropionamide compound with various secondary aromatic amines and ethers. Reactions between RO_2 radicals, produced during radioinduced oxidation of polycaproamide, indexed as polyhexanamide, films with diphenylamine and bis[2-(4-phenylaminophenoxy)ethyl] ether were also studied. The list of admixtures, their concentrations, and melting points are tabulated. The irradiation of butylpropionamide and polycaproamide with the admixtures was carried out by ^{60}Co γ rays at liquid nitrogen and room temperatures, either in a vacuum or under oxygen pressure of 3 to 5 atm. (R.V.J.)

27782 RADIATION-INDUCED SOLID-STATE EXPLOSIVE POLYMERIZATION OF ACETALDEHYDE. Syui, Tsin; Wang, Lansing; Syui, Tzi-pin; Chein, Pao-kung. K'o Hsueh T'ung Pao, 17: 405-7(May 15, 1966).

It was shown that the radioinduced solid state polymerization of acetaldehyde results essentially in a thermal explosion. Thermographs indicated that polymerization begins when the irradiated acetaldehyde is heated to a certain temperature and after a very short induction period the reaction becomes explosive, with a rapid rise in temperature. The temperature at which explosion takes place decreases with increasing irradiation dose. This polymerization belongs to a type of chain reaction in which the growth step is initiated by a fixed active center (instantaneous nucleation) without termination. The number of active centers produced by irradiation is directly proportional to the amount of irradiation dose. The average value of activation energy obtained was 5.6 ± 0.5 kcal/mole. By analysis of the differential thermal peak, it was shown that the polymerization reaction is accomplished within a short time, <40 sec. (BBB)

27783 PROPERTIES OF IRRADIATED POLYETHYLENE AT THE MELTING POINT. Tsuzi, Y.; Tada, S.; Kawashima, M. (Sumitomo Electric Ind. Ltd., Japan). Elec. Eng. Jap. (Engl. Transl.), 87: 84-9(Feb. 1967).

An irradiated polyethylene that does not melt above the softening point was developed. To evaluate the possibility of using the irradiated polyethylene at high temperatures, the following characteristics were examined: mechanical properties and their change at the softening point, electrical properties and the effect of residual charge from the irradiation on them, and life test and the deterioration due to oxidation. Experiments showed that the degree of crystallinity of the polyethylene decreased near the softening point. The results for several samples of polyethylene are tabulated. The samples were irradiated with 1.7-MeV electrons at room temperature at 10-MRAD steps in the range of 5 to 100 MRAD. Measurements were made at 130, 150, and 170°C. Results showed that β-irradiated polyethylenes can be used in the temperature range of 80 to 100°C, while the unirradiated polyethylenes must be used below 60°C. Furthermore, the irradiated polyethylenes can be used above their softening points, up to 120°C, for a short time. Some anomalies in their electrical properties can be overcome by heating them above their softening point and then cooling them before use. (BBB)

27784 SUSPENSIONS OF RADIATION-SULFOCHLORINATED POLYPROPYLENE. Dzhagatspanyan, R. V.; Khromenkov, L. G.; Korolev, B. M. (NII of the Chlorine Industry, Moscow). Kolloid. Zh., 29: 489-92(1967). (In Russian).

The electron microscope was used to investigate highly disperse suspensions in water–alcohol of isotactic polypropylene sulfochlorinated as a liquid under γ radiation. Supramolecular polypropylene structures were found to be formed directly in the process of polymerization. In sulfochlorination of polypropylene, the crystalline structure breaks down; the rate of the collapse of structure is greater than in the case of polyethylene. Several illustrations note this breakdown; photographs illustrate the initial structure that after sulfochlorination has reached 25.1% Cl and 4.7% S, and again after sulfochlorination has reached 38.8% Cl and 4.8% S. Decomposition rates are a function not only of composition of the polymers but also of their surface morphology. (BBB)

27785 ON γ RADIOLYSIS OF BROMOBENZENE–ALCOHOL SOLUTIONS. Schulte-Frohlinde, Dietrich; Salzwedel, Manfred (Kernforschungszentrum, Karlsruhe, Ger.). Ann. Chem., 709: 59-62(1967). (In German).

The G values for HBr production in bromobenzene-isopropanol and bromobenzene–benzyl alcohol mixtures were measured as a function of mixing ratio, temperature, and additives. In the presence of isopropanol a chain reaction occurs in which benzene, acetone, and HBr are produced. The G value reaches a maximum at about a molar ratio of components of 1:1 under exclusion of O_2. The G value at the maximum is about 20 at 25°C; it increases with increasing temperature in the range −40°C to 50°C; it decreases with addition of other substances (5 wt.%) in the order biphenyl–naphthalene–acetophenone–nitrobenzene; cyclohexane and benzene have little effect. The reaction with benzyl alcohol shows no evidence of this chain reaction; the G value is about 4 and independent of composition, temperature, or additives. A mechanism is suggested for the ^{60}Co γ-induced reaction. (BBB)

27786 CROSSLINKING OF POLYMERS BY RADIATION. Charlesby, A. (Royal Military College of Science, Swindon, Eng.). Chimia (Aarau), 22: 153-6(Apr. 16, 1968).

The use of radiation in the crosslinking of polymers is reviewed. Topics discussed are: radiation mechanisms, crystal morphology, crosslinking in solution, and reinforcement. (J.G.B.)

27787 MAGNETIC RESONANCE STUDIES ON IRRADIATED CRYSTALS OF CHLOROACETYL DL-ALANINE. Wells, James W.; Box, Harold C. (Roswell Park Memorial Inst., Buffalo, N. Y.). J. Chem. Phys., 48: 2542-6(Mar. 15, 1968).

The rotation of the methyl group in the free radical $ClCH_2-CONH-C(CH_3)COOH$ was studied by ESR and ENDOR spectroscopy. The results are analyzed using a quantum-mechanical hindered rotor model with Mathieu functions as basis functions. The experimental results indicate a barrier height of less than 0.5 kcal/mole. (auth)

27788 AN ELECTRON SPIN RESONANCE STUDY OF THE FREE RADICALS INDUCED IN O-METHYLISOURONIUM CHLORIDE BY X-IRRADIATION AT 77°K. Cadena, D. G.; Rowlands, J. R. (Southwest Research Inst., San Antonio, Tex.). J. Chem. Soc. B, No. 4, 485-8(1968).

Electron spin resonance studies of single crystals of O-methylisouronium chloride show that two types of radicals are produced by irradiation at 77°K with x rays. On annealing at room temperatures, these decay to yield one room temperature-stable species. The structures of both low temperature- and room temperature-stable radicals are discussed. (auth) (UK)

27789 ELECTRON MICROSCOPIC STUDY OF POWDER POLYMER PARTICLE OF RADIO-SULFOCHLORINATED POLYETHYLENE AND POLYPROPYLENE BY REPLICA TECHNIQUE. Khromenkov, L. G.; Shagina, S. G.; Dzhagatspanyan, R. V. Vysokomol. Soedin., Ser. B, 10: 34-6(Jan. 1968). (In Russian).

Particles of polyethylene and polypropylene represent agglomerates of latex particles coupled by cohesive forces. It was established that in the radio-sulfochlorination process the surface of the powder polymer particles does not undergo significant changes. A method of partial replication of difficultly soluble polymer powders was proposed. (tr-auth)

27790 QUANTITATIVE INFRARED-SPECTROSCOPIC INVESTIGATION OF THE TEMPERATURE DEPENDENCE OF THE CCl STRETCHING VIBRATIONS OF POLYVINYL CHLORIDE. Pohl, H. U.; Hummel, D. O. (Univ., Cologne). Makromol. Chem., 113: 190-202(Apr. 11, 1968). (In German).

Vinyl chloride was polymerized in mass at different temperatures by γ-irradiation. The infrared spectra of the polymers were investigated at temperatures between 30 and 200°C. A method is given for the graphical separation of complexes of superimposed absorption bands. Thus the complex of the ν(CCl) vibrations was separated into 7 bands at 603, 613, 624, 636, 647, 677, and 696 cm^{-1}. The temperature dependence of the relative integral absorbance of these bands was determined; the correlation to certain configurations and conformations is discussed. (auth)

27791 RADIATION POLYMERIZATION OF PERHYDROTRIPHENYLENE-INCLUDED BUTADIENE. Loeffelholz, Marco (Istituto Ricerche G. Donegani, Novara, Italy); Farina, Mario; Rossi, Umberto. Makromol. Chem., 113: 230-5(Apr. 11, 1968).

The planar isomer of perhydrotriphenylene (PHTP) is a new host molecule for the inclusion polymerization of butadiene. By γ-irradiation of the PHTP-monomer adduct an inclusion compound between PHTP and the polymer is obtained, as revealed by its melting point. The recovered polymer has a highly regular trans-1.4-structure. The effect of different variables (dose, dose-rate, PHTP/monomer ratio) was studied. (auth)

27792 RADIOLYSIS AND PHOTOLYSIS OF DIPHENYL CARBONATE. Davis, A.; Golden, J. H. (Explosives Research and Development Establishment, Waltham Abbey, Eng.). J. Chem. Soc., B, No. 4, 425-7(1968).

The products of electron and ultraviolet irradiation of diphenyl carbonate and related carbonates were examined in detail. The origin of the products and the importance of intramolecular cage recombinations and re-arrangements in the radio- and photo-induced degradations are discussed. (auth) (UK)

27793 UNSTABLE INTERMEDIATES. PART LI. AN ELECTRON SPIN RESONANCE STUDY OF RADICALS AND RADICAL PAIRS FORMED BY IRRADIATION OF ORGANIC CARBONATES. McRae, J. A.; Symons, M. C. R. (Univ. of Leicester, Eng.). J. Chem. Soc., B, No. 4, 428-30(1968).

Electron spin resonance spectra obtained from diaryl carbonates, γ-irradiated at 77°K, show that one of the major results of irradiation is the pairwise trapping of phenoxy radicals. The ESR results support the chemical evidence that elimination of carbon monoxide and subsequent cage recombination are important processes in the radiation chemistry of aromatic carbonates. The ESR spectra of γ-irradiated polycarbonates and ultraviolet-irradiated diphenyl carbonate are also discussed. (auth) (UK)

27794 RADIOCHEMICAL POLYMERIZATION OF ACENAPHTHYLENE. Muller, Jean-Claude (CERCHAR, Creil, France). J. Chim. Phys., 65: 569-77(Mar. 1968). (In French).

The radiation polymerization of acenaphthylene was investigated between 0 and 130°C (MP = 92 to 93°C). In the liquid phase, the polymerization process was normal: constant rate of polymerization up to rather high degrees of polymerization, reaction order α with respect to radiation dose rate approximately equal to 0.5, activation energy of the radiation polymerization rate of the order of 10 kcal/mole. Near the melting point the reaction order α decreased slightly; this is presumably due to a gel-effect. In the solid phase the polymerization kinetics were accelerated, the reaction order α was found to be above 0.5 and considerable post-effect polymerization was observed. At temperatures above 80°C these characteristic features became indistinct and were more like those observed in the liquid phase. The molecular weight of the polymers was rather independent of the degree of polymerization at temperatures below 50°C; above 50°C, it increased with the degree of polymerization and at a given conversion, with the temperature of polymerization. This behavior was accounted for by assuming that the chain termination does not occur normally and that the propagation depends on the diffusion rate of the monomer towards the end-groups of the growing chains. Since the motion of molecules increased with temperature, there was a progressive evolution towards the classical process of liquid-phase polymerization when temperature increased. (auth)

27795 CONSTANT TEMPERATURE BATH FOR IRRADIATIONS AT LOW TEMPERATURES IN POND FACILITIES. O'Donnell, J. H. (Univ. of Queensland, Brisbane). Chem. Ind. (London), No. 15, 481-3(Apr. 13, 1968).

A simple rig is described, for operation in the temperature range from 15 to −196°C, which will fit easily into a standard irradiation can. Liquid nitrogen cooling is employed. The dose rate for samples in the rig is about 70% of that in the air-filled can for ^{60}Co γ rays. The rig can also be operated at temperatures up to 150°C, and thus can be used for studying temperature dependence over a wide range at constant dose rate. Some operational safety precautions are mentioned. The rig has operated satisfactorily from −100 to +10°C at dose rates up to 0.5MR/hr for kinetic runs up to 16 hr. Kinetic plots for the polymerization of nonyl methacrylate using the rig at −80°C and dose rates of 10,600 and 40,000 R/hr are shown. (U.K.)

27796 AN ELECTRON SPIN RESONANCE INVESTIGATION OF X-IRRADIATED DL-METHIONINE. Cadena, D. G., Jr.; Rowlands, J. R. (Southwest Research Inst., San Antonio). J. Chem. Soc., B, No. 4, 488-91(1968).

Electron spin resonance studies of single crystals of DL-methionine irradiated and measured at 77°K showed the presence of two types of free radicals. Upon annealing, one of these radicals decayed, while the second showed no change in concentration. A third free-radical species was produced in the annealing process. The structure of these radicals is discussed. (auth) (UK)

27797 RADIOLYSIS OF CYLCOHEXANE IN A XENON MATRIX AT 77°K. Stone, J. A. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Chem., 46: 1267-77(Apr. 15, 1968).

Low concentrations (less than 7 mole %) of cyclohexane and cyclohexane-d_{12} were irradiated in xenon matrices at 77°K. The products were qualitatively the same as those obtained by the radiolysis of the pure hydrocarbon but the yields differed. In particular $G(H_2) = 6.7$ for 6.2 mole % cyclohexane was much higher than that for solid cyclohexane at the same temperature (4.65). (All G values were calculated on energy absorbed in the whole sample.) The G values for products were reduced to limiting values, which are ~50 to 75% of the initial ones, by low concentrations of SF_6. Carbon tetrachloride reduced the yields to a greater extent than did SF_6. Both ionic and nonionic product formation probably occurred. Ion chamber dosimetry was used to determine the energy absorption by xenon which is anomalous due to the presence of low energy, scattered gammas in the ^{60}Co source. (auth) (Canada)

27798 EFFECTS OF ELECTRON SCAVENGERS IN THE RADIOLYSIS OF WATER VAPOR. Dixon, R. S.; Bailey, M. G. (Atomic Energy of Canada Ltd., Pinawa, Manitoba). Can. J. Chem., 46: 1181-6(Apr. 15, 1968). (AECL-3049).

Water vapor irradiated with x rays in the presence of nitrous oxide gives mainly nitrogen and oxygen together with small amounts of hydrogen and, possibly, hydrogen peroxide. The yield of nitrogen $G(N_2) = 3.0 \pm 0.3$, is constant over a wide range of conditions and $G(O_2) = 1.6 \pm 0.3$ after an induction period. The hydrogen yield is constant at low doses with $G(H_2) = 0.45 \pm 0.1$, but reaches a steady state at higher doses. The nitrogen yield is equated with the yield of scavengeable electrons in water vapor, the value $g(e) = 3.0 \pm 0.3$ being in reasonable agreement with the theoretical value based on $W(H_2O) = 30$ eV. Addition of other electron scavengers to water vapor containing nitrous oxide suppresses the nitrogen yield by competing efficiently for electrons. On the basis of their efficiency in suppressing the nitrogen yield, limiting values for the relative rates of reaction of N_2O, SF_6, CCl_4, and HCl with electrons in water vapor are obtained and comparisons are made with their known electron attachment cross sections in the gas phase. (auth) (Canada)

27799 RADIATION-INDUCED HYDROXYLATION OF NITROBENZENE IN DILUTE AQUEOUS SOLUTION. Fendler, J. H.; Gasowski, G. L. (Carnegie-Mellon Univ., Pittsburgh). J. Org. Chem., 33: 1865-8(May 1968).

The isomeric nitrophenols were quantitatively determined by gas–liquid partition chromatography in irradiated solutions of dilute aqueous nitrobenzene. The relative rates of hydroxylation for $C_6H_5NO_2$ and $C_6D_5NO_2$ were found to be identical and therefore the initial step of hydroxylation is the addition of ·OH to the aromatic ring. The G values obtained for nitrophenols suggest preferential dimer formation. If the solvated electrons are not completely scavenged additional nitrophenols are produced by a complicated set of reactions involving the nitro-substituted hydroxycyclohexadienyl radical, the dimers, and their subsequent products. The mechanisms for these processes are discussed. (auth)

27800 REACTIONS OF POSITIVE IONS IN THE ENERGY RANGE 0.5 TO 1200 keV WITH ACETYLENE. Abbe, Jean-Charles (Centre de Recherches Nucleaires, Strasbourg). J. Chim. Phys., 65: 472-4(Mar. 1968). (In French).

A double stage mass spectrometer was used to study the patterns of positively charged fragments of acetylene from bombardment with different positive ions in the energy ranges from 0.5 to 2 keV and from 20 to 1,200 keV. (auth)

27801 SCAVENGING OF IONS IN IRRADIATED LIQUIDS. Hummel, A. (Reactor Inst., Delft, Netherlands). J. Chem. Phys., 48: 3268-71(Apr. 1, 1968).

Monchick's theory of the probability of reaction between two particles in each other's potential field while a scavenger is present, was used to study the scavenging of ions formed in dielectric liquids by high-energy radiation. The ions originating in a track of a fast electron are formed in groups. Only reaction of the last pair in each group, after recombination of the others, was considered. The distribution of separations of the last pairs in a track of a 1-MeV electron in hexane was estimated from conductivity measurements, by applying Onsager's theory of the probability of recombination of an ion pair. This distribution was used to calculate the concentration dependence of the yield of reaction of the ions with a scavenger. The calculated concentration dependence was compared with several experimental results from the literature. (auth)

27802 STUDY ON THE CAUSE OF SMOKY COLORATION IN α-QUARTZ BY ^{60}Co γ-IRRADIATION. Lee, Hee Yong; Park, Keung Shick (Atomic Energy Research Inst., Seoul). J. Nucl. Sci. (Seoul), 7: No. 1, 122-30(Oct. 1967). (In Korean).

The causes of smoky coloration of domestic α-quartz due to ^{60}Co γ irradiation were examined. It seems that the smoky coloration in α-quartz is mainly associated with aluminum impurity rather than its crystalline state but the latter also may contribute partially to the coloration. Irradiation of crystalline α-quartz causes the direct displacement of atoms to create defect centers, and also causes an ionization process making electron-hole pairs. It is presumed that an aluminum atom substituted by a silicon atom in its vacancy acts as a recombination center in which a hole is trapped and consists of a color center of optical absorption in 450 to 460 mμ bands. Fused quartz at low temperature is also colored as in α-quartz when the aluminum impurity is incorporated in it. In this case the crystalline state is apparently not amorphous. Experimental evidence of such colored quartz is presented as well as the mechanism of its defect model. (auth)

27803 PREPARATION OF CARRIER FREE ^{24}Na. Lee, Byung Heon; Rie, Jong Du (Atomic Energy Research Inst., Seoul). J. Nucl. Sci. (Seoul), 7: No. 1, 104-5(Oct. 1967). (In Korean).

Carrier free ^{24}Na was prepared by separation with cation exchanger, Dowex-50w × 12, after irradiation in the TRIGA MARK II Reactor of a magnesium oxide target. The magnesium oxide was purified by cation exchanger. (auth)

27804 A STUDY ON THE PREPARATION OF ^{18}F-CONTAINING ORGANIC COMPOUNDS. II. Kim, You Sun; Lee, Youn Yung; Kim, Ki Soo (Atomic Energy Research Inst., Seoul). J. Nucl. Sci. (Seoul), 7: No. 1, 86-90(Oct. 1967). (In Korean).

By irradiating lithium carbonate in the pneumatic tube system of the Korean research reactor, ^{18}F was prepared in the $K^{18}F$ form. The $K^{18}F$ was reacted with organic halogen or nonhalogen compounds both by heating and γ irradiation in presence of dimethylformamide. It was found that the labeled yields of the radioinduced reaction were better than those of the heating proce-

dure. In the case of nonhalogen compounds, fluorination occurred only under γ irradiation. (auth)

27805 RADIATION EFFECT ON THE OPTICAL ROTATORY ACTIVITY IN SUCROSE. 2. THEORY. Lee, Sang Soo; Park, Dae Yoon; Lee, Chong Ki (Yonse Univ., Seoul). J. Nucl. Sci. (Seoul), 7: No. 1, 17-20(Oct. 1967).

Theoretical treatment of the results of the irradiation of sucrose is presented. The results are explained on the basis of a second order chemical process of recombination between free carbon radicals and hydrogen ions which must be dominantly populated in the aqueous solution of irradiated sucrose. The linear correlation between the specific rotation and the integrated reactor power and the aging equation were derived. Also the gradient of the aging curve was found to be approximately parabolic as predicted by the theory. (J.G.B.)

27806 RADIATION EFFECT ON THE OPTICAL ROTATORY ACTIVITY IN SUCROSE. 1. EXPERIMENT. Lee, Chong Ki. (Yonse Univ., Seoul); Sauer, R. G.; Lee, Sang Soo; Park, Dae Yoon. J. Nucl. Sci. (Seoul), 7: No. 1, 13-16(Oct. 1967).

Radiation effects on sucrose were investigated by measuring the optical rotatory activity in its aqueous solution. Advantages of the polarimetric method over the conventional chemical dosimetry are discussed. Solid sucrose was irradiated in the rotary specimen rack of TRIGA-II reactor, then dissolved in distilled water for optical rotation measurement. A linear correlation was established experimentally between the specific rotation and the integrated reactor power to which the integrated radiation dose is proportional. The correlation is represented numerically by the following equation: $\theta = (66.46 - 0.00097\ W)^0$. θ was found additive for radiation doses. It has, however, severe aging effects of $\partial\theta/\partial t < 0$, as a result of the dissolution taking place in water. Results of spectrophotometric measurements are also presented. Similar aging effects were observed in the spectral transmission curve. Theoretical treatment of the results is presented in a separate paper. (auth)

27807 IMPROVED SAMPLE GEOMETRIES FOR FAST NEUTRON IRRADIATIONS. Hite, J. R.; Axtmann, R. C. (Princeton Univ., N. J.). Contract AT(30-1)-2807. Int. J. Appl. Radiat. Isotop., 19: 439-45(May 1968). (NYO-2807-42).

A Monte Carlo calculation provided a comparison of radiolytic yield efficiencies in a series of cylindrical sample geometries for irradiation by neutrons from the $^3H(d,n)^4He$ reaction. Improvements of better than an order of magnitude were found over geometries used in previous work. The results permit optimizing either the product concentration or the total amount of product. Use of sample fluid to cool the tritium target of the neutron generator offers advantages in some cases. A by-product of the Monte Carlo procedure gave estimates of the linear energy transfer (LET) for 14-MeV neutron irradiation of hydrocarbons. Not surprisingly, the average initial LET depends sensitively on the carbon-to-hydrogen ratio of the hydrocarbon. (auth) (UK)

27808 STUDY OF THE SEPARATION OF ^{99m}Tc FROM ^{99}Mo ON Al_2O_3 AND THE PROCEDURE FOR THE PRODUCTION OF ^{99m}Tc. Ravnik, V.; Gorenc, B. (Nuklearni Institut Jozef Stefan, Ljubljani, Yugoslavia. Univ., Ljubljani, Yugoslavia). Vestn. Slov. Kem. Drus., 13: 19-24(Jan.-Dec. 1966). (In Slovak).

Results obtained by column separation of ^{99m}Tc from ^{99}Mo on aluminium oxide with several mineral acids are presented. The dependence of the distribution coefficients of Tc and Mo between their aqueous solutions and aluminium oxide on the concentration of (HCl, HNO_3, H_2SO_4, $HClO_4$) acids within the range of 3 to 10^{-2} M was determined. The elution curves of Tc for some acids are given as well as a procedure for the production of ^{99m}Tc in the generator for tracer and medical purposes. (auth)

27809 A NOTE ON THE MEASURE OF DEGREE OF ENRICHMENT OBTAINED BY SZILARD-CHALMERS REACTION. Matsuura, Tatsuo (Rikkyo Univ., Yokosuka, Japan). J. Nucl. Sci. Technol. (Tokyo), 5: 192-3(Apr. 1968).

The nature of specific activities and enrichment factors obtained by the Szilard-Chalmers reaction is discussed. It is concluded that enrichment factors cannot be meaningfully compared unless obtained under the same irradiation conditions in respect to irradiation time and neutron flux. (J.G.B.)

27810 RATE OF THERMAL DECOMPOSITION OF γ-IRRADIATED POTASSIUM PERMANGANATE. Erofeev, B. V.; Protashchik, V. A. (Inst. of Physics and Organic Chemistry, Minsk). Dokl. Akad. Nauk SSSR, 172: 1129-32(Feb. 11, 1967). (In Russian).

A total of 23 irradiated and unirradiated $KMnO_4$ samples with various particle sizes were investigated at ^{60}Co radiation doses of 5, 15, and 25×10^6 R. The kinetics of thermal decomposition were determined at 201.5, 212, 218, and 233°C. It was found that the data fit the following equations: $\log k_{[X]} = \log k_0 + C[X]^m$ or $k_{[X]} = k_0 \exp 2.3\ C[X]^m$. Here $k_{[X]}$ is the rate constant for a $KMnO_4$ sample obtaining an irradiation dose [X], and k_0 is the rate constant for the unirradiated sample. Values of m and C are tabulated, and differ only slightly for the various temperatures. The number of potential growth centers was estimated in the irradiated solid, and was found to vary from 26 to 2860 depending on the dose. (TTT)

27811 IONIC REACTIONS IN THE γ RADIOLYSIS OF ETHER SOLUTIONS OF D_2S. Pukies, J.; Henglein, A.; Meissner, G. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Z. Phys. Chem. (Frankfurt), 57: 177-86(Feb. 1968). (In German).

D_2, HD, and H_2 were produced by the γ-irradiation of solutions of D_2S in ethers [2-methyltetrahydrofuran (MTHF), diethyl and dimethyl ether]. D_2 resulted from the scavenging of ionic intermediates of the radiolysis. It was concluded from the temperature dependence of the yields of the various isotopic hydrogen molecules that D_2 scavenged ionic intermediates more efficiently at lower irradiation temperatures. $G(D_2)$ reached a minimum value, $G(H_2)$ and G(HD) had maxima at 75 mole % of n-hexane in mixtures of MTHF and n-hexane. This is explained by the inhibition of cationic reactions in n-hexane solutions by MTHF and by new ionic processes which become possible at sufficiently high dielectric constant of the solvent mixture. (auth)

27812 POLYMERIZATION OF N-p-TOLYLMALEIMIDE CAUSED WITH γ-IRRADIATION OF ^{60}Co. Migunova, I. I.; Ivanov, V. S. Vysokomol. Soedin., Ser. A, 633-9(Mar. 1968). (In Russian).

N-p-tolylmaleimide was polymerized with ^{60}Co γ-rays in solid and liquid state. The effect of dose and dose rate was studied. Solid-state polymerization proceeded with autoacceleration which could be regulated with temperature and dose rate. The polymer has mainly treo-diisotactic structure. Radiation chemical yields of the polymer at 120°C and above are high and especially high (G up to 10^4) in the liquid phase. The polymer was characterized on solubility, intrinsic viscosity, temperatures of decomposition and softening. X-ray diagrams and infrared spectra of the monomer and the polymer were taken. Poly-N-p-tolylmaleimide is a thermo- and chemically stable polymer. (auth)

27813 MECHANISM OF THE RADIOLYSIS OF AQUEOUS SOLUTIONS OF BENZENE IN ACID AND ALKALINE MEDIUM. Zhikharev, V. S.; Vysotskaya, N. A. (Inst. of Physical Chemistry, Kiev). Zh. Fiz. Khim., 42: 360-5(Feb. 1968). (In Russian).

During radiolytic oxidation of aqueous solutions of benzene in the presence of oxygen, the paths of the displacement of oxygen were studied by means of ^{18}O and the radiochemical yields of phenol and hydrogen peroxide in acid and alkaline solution were determined. It was established that the volume of oxygen in the phenol from the gaseous phase is reduced with increase of the pH. The data obtained are explained by transition of oxygen in the phenol from the gaseous phase by means of the subsequent formation from hydrogen peroxide and hydroxyl radicals and with the interaction of the hydroxyl radicals with benzene. (tr-auth)

27814 INVESTIGATION OF THE RADIATION STABILITY OF THE SULFOCATIONITE KU-2 IN THE LITHIUM, SODIUM, AND POTASSIUM FORM. Skorokhod, O. R.; Stankevich, I. B. (Belorussian State Univ., Minsk). Zh. Fiz. Khim., 42: 516-18(Feb. 1968). (In Russian).

The effect of γ radiation from ^{60}Co with an integral dose of 1×10^8 R on the sulfocationite KU-2 in the Li, Na, and K forms, associated with different C–S and C–C bonds, led to an increase of the sorption properties of the ionite with respect to cresol, resorcinol, and phenol. Destruction of the ionite during irradiation of the salt forms occurred to a slighter degree than during irradiation of the hydrogen form of the ionite. (tr-auth)

27815 ELECTRON MICROSCOPE STUDY OF THE RADIOCHEMICAL POLYMERIZATION OF MONOCRYSTALS OF TETROXANE. Cannavo, Christian; Deschamps, Jacqueline; Hayashi, Koichiro; Sella, Claude (CNRS, Bellevue, France. CEA, Saclay, France. Kyoto Univ.). Compt. Rend., Ser. C, 266: 777-80(Mar. 11, 1968). (In French).

The radiochemical polymerization in the solid state of monocrystals of tetroxane was studied by diffraction and electron microscopy. This technique under vacuum at low temperature made it possible to follow the formation of the polymer in the interior of the monomeric crystal and its development in the form of oriented fibrils. (tr-auth)

27816 EPR STUDY OF THE RADICALS FORMED BY IONIZING RADIATIONS IN SOME HYDROCARBONS. Thyrion, Fernand; Dodelet, Jean-Pol; Fauquenoit, Christian; Claes, Paul (Univ., Louvain, Belg.). J. Chim. Phys., 65: 227-34(Feb. 1968). (In French).

Hydrocarbons condensed at 77°K were irradiated by X or γ rays. The radicals produced were studied by ESR. The compounds irradiated were isobutane, pentane, hexane, isopentane, 3-methylpentane, neopentane, and neohexane. The nature of the produced radicals was independent of the condensation technique and the nature of the ionizing ray; the radical species did not change when the temperature of the irradiated sample was increased. The radicals were produced by rupture of a C–H bond. Generally, the rupture became easier going from primary to tertiary carbon. (auth)

27817 COMPARISON OF RADIATION AND PHOTOCHEMICAL CROSSLINKING OF POLYETHYLENE. Kachan, A. A.; Sirota, A. G.; Chernyavskii, G. V.; Shrubovich, V. A. Vysokomol. Soedin., Ser. A, 10: 471-8(Mar. 1968). (In Russian).

Radiation and photochemical crosslinking of polyethylene were compared. In the photosensitized reaction light energy is used for production of the sensitizer radicals, abstracting hydrogen atoms from the macromolecules, and increasing the crosslinks between the chains. In most radioinduced reactions sensitizers act as crosslinking agents for activation of macromolecules with irradiation. For thin films the photochemical reaction has some advantages, such as simplicity and the possibility of carrying out the reaction in air without noticeable loss of the films quality. (auth)

27818 ANNEALING OF GAMMA-IRRADIATION DAMAGE IN CRYSTALLINE LEAD NITRATE. Mohanty, S. R.; Upadhyay, S. R. (Banaras Hindu Univ., India). Z. Phys. Chem. (Frankfurt), 57: 234-48(Feb. 1968).

A kinetic study of the annealing of γ-irradiation damage in crystalline lead nitrate is presented. The annealing can be represented on models for simple interstitial vacancy recombination and also as a bimolecular process. It is considered that the process corresponds to the random recombination of the damage fragments, NO and O_2^-, throughout the crystal. (auth)

27819 INVESTIGATION OF THE PURITY OF ^{90}Y AND ^{140}La PRODUCED IN ISOTOPE GENERATOR BY MEANS OF SEPARATION WITH PAPER ELECTROPHORESIS. Deak, Maria. Magy. Kem. Lapja, 23: 65-8(Feb. 1968). (In Hungarian).

It was stated that ^{90}Y of 99.9999% purity can be produced by the Sr–Y generator introduced in the paper and ^{140}La of 99.99% purity by Ba–La generator. The quick paper electrophoretic method given was found to be suitable for high sensitivity purity investigation. (auth)

27820 IMPORTANCE OF THE GRAFTING REACTIONS IN γ-RAY POLYMERIZATION OF ETHYLENE AND ETHYLENE–CARBON MONOXIDE MIXTURES. Munari, S.; Russo, S.; Vigo, F. (Univ., Genoa. CNR, Genoa). J. Polym. Sci., Part B, 6: 23-31(Jan. 1968).

Studies on the γ-radioinduced copolymerization of ethylene and carbon monoxide were continued. Previous studies indicated that subsequent to the constant initial stage of the process, autoacceleration starts due to the preformed polymer. Chemical effects in the autoacceleration stage of ethylene polymerization and the absence of autoacceleration in polyketones copolymerization, due to the inability of the radicals to give grafting reactions, were confirmed. EPR studies were carried out on the nature and properties of polyketonic radicals. Results lent support to the theory that the role of the preformed polymer in the autoacceleration process is connected to the creation of new long-lived radicals in the preformed polymer, resulting in an increase of total yield due to grafting reactions. (J.G.B.)

27821 VAPOR-PHASE RADIATION GRAFT COPOLYMERIZATION USING SOLID MONOMERS. Hayakawa, Kiyoshi; Kawase, Kaoru; Yamakita, Hiromi (Government Industrial Research Inst., Nagoya, Japan). J. Polym. Sci., Part B, 6: 33-7(Jan. 1968).

A simultaneous irradiation technique and a preirradiation technique were used for inducing the vapor-phase graft copolymerization of solid monomers with polymers. Simultaneous grafting was accomplished by the γ- or uv-irradiation of the monomer adsorbed on polymer films or fibers. The grafting of monomers acrylamide, acenaphthylene, maleimide, sorbic acid, or trioxane to polyethylene films and that of acrylamide and acenaphthylene to polypropene fibers was accomplished with varying results. In the preirradiation technique, fibers were γ-irradiated at –78°C, then exposed to acenaphthylene or acrylamide vapor. The degree of grafting using this technique was especially low. (J.G.B.)

27822 TACTICITY OF POLY(METHYL METHACRYLATE) PREPARED BY RADICAL POLYMERIZATION WITHIN A MONOLAYER OF METHYL METHACRYLATE ADSORBED ON MONTMORILLONITE. Blumstein, Alexandre; Watterson, Arthur C. (Lowell Technological Inst., Mass.). J. Polym. Sci., Part B, 6: 69-74(Jan. 1968).

Montmorillonite–methyl methacrylate complexes were polymerized in two ways with similar results: with γ-irradiation and with benzoyl peroxide initiation. Tacticity was evaluated through NMR spectral studies. A schematic diagram of the association between molecules of methyl methacrylate and exchangeable ions is presented. (J.G.B.)

27823 EFFECT OF γ RADIATION ON SELECTED PHARMACEUTICALS. Rasero, Lawrence J. Jr. (E. I. duPont de Nemours and Co., Newark, Del.); Skauen, Donald M. J. Pharm. Sci., 56: 724-8(June 1967).

The effect of γ radiation from ^{60}Co on aqueous solutions of chlorobutanol, theophylline, and sodium carboxymethylcellulose (CMC) packaged in glass and polyethylene containers was investigated with a view toward possible radiosterilization of these compounds in aqueous solution. Doses up to 2.1 Mrad were used. Chlorobutanol solutions were analyzed for appearance, pH changes, chlorobutanol degradation, and production of chlorine, acetone, and hydrogen peroxide. Theophylline solutions were analyzed for appearance, pH changes, theophylline degradation, and production of hydrogen peroxide. Solutions of CMC were analyzed for viscosity changes. All systems showed pronounced changes, even at low radiation levels (6 Krad). There were no effects that could be attributed to the container. The production of hydrogen peroxide in chlorobutanol solutions presented an unusual result. The level of hydrogen peroxide increased rapidly with dose, reached a peak, and then underwent a reduction in concentration. The point of maximum hydrogen peroxide concentration occurred when a precipitate became evident. The degradation of theophylline solutions was similar to that of chlorobutanol solution; the more concentrated solutions showed less degradation, on a percent basis, than dilute solutions. But the milligram loss for all solutions remained relatively constant, as an indication of an indirect effect on the theophylline molecule. Intrinsic viscosity determinations on CMC indicated a profound reduction in molecular weight. It was concluded that γ irradiation is not a suitable method for sterilizing aqueous solutions of these products. (BBB)

27824 IONIZATION OF LIQUIDS BY RADIATION: MEASUREMENT BY A CLEARING FIELD. Schmidt, Werner F.; Allen, A. O. (Brookhaven National Lab., Upton, N. Y.). Science, 160: 301-2(Apr. 19, 1968). (BNL-12127).

A method was developed for determining the yield of free ions formed by irradiation of a liquid with high-energy x rays. Contrary to expectation, branched-chain paraffins produced many more free ions than straight-chain paraffins, and the ether 1,4-dioxane produced only a third as many free ions as its hydrocarbon analog, cyclohexane. (auth)

27825 SATURATION AND REMOVAL OF ELECTRON TRAPPING SITES IN HYDROCARBON GLASSES. Shirom, Miriam; Willard, John E. (Univ. of Wisconsin, Madison). Contract AT(11-1)-1715. J. Amer. Chem. Soc., 90: 2184-5(Apr. 10, 1968). (COO-1715-142).

A study was made of electrons trapped in γ-irradiated organic glasses. It was found in each of 3 glassy hydrocarbons (methylcyclohexane (MCH), 3-methylpentane (3MP), and 3-methyloctane (3MO)) that increasing γ-dose caused the electron concentration to increase, pass through a maximum, and then decrease. Reactions that might conceivably occur between trapped electrons and species produced by the ionizing radiation are discussed. In contrast to the electrons' signals, the free radical ESR signals from MCH, 3MP, 3MO, and methyltetrahydrofuran matrices grew linearly with dose. (D.H.M.)

27826 IONIZATION OF LIQUIDS BY RADIATION: MEASUREMENT BY CHARGE SCAVENGING. Capellos, C.; Allen, A. O. (Brookhaven National Lab., Upton, N. Y.). Science, 160: 302-3 (Apr. 19, 1968). (BNL-12128).

Pulse radiolysis of dilute solutions of triphenylcarbinol in saturated hydrocarbon gives spectra of the triphenylmethyl free radical, $(C_6H_5)_3C\cdot$, and cation, $(C_6H_5)_3C^+$. The yield of the ion is independent of the carbinol concentration, and is thought to measure the yield of free ions generated in the solvent. The relative yields of ions thus found in cyclohexane and 2,2,4-trimethylpentane agree with measurements made by the clearing-field method. (auth)

27827 CHEMICAL EFFECTS OF RADIATION THERMAL NEUTRON CAPTURE. PART 14. ANNEALING BY IONIZING RADIATION. Baumgartner, F.; Maddock, A. G. (Cambridge Univ., Eng.). Trans. Faraday Soc., 64: 714-20(Mar. 1968).

The thermal aspects of radiation annealing were investigated. Neutron-irradiated potassium chromate crystals were exposed to electron and gamma radiation at various temperatures. Results indicated that most thermal annealing is a consequence

of the radiation dose received during the neutron irradiation. A unified model for the annealing process is proposed. (auth) (UK)

27828 EPR LOW-TEMPERATURE CENTERS IN IRRADIATED $BaWO_4$ AND $SrWO_4$ CRYSTALS. Novozhilov, A. I.; Samoilovich, M. I.; Potkin, L. I. (All-Union Scientific-Research Inst. of Mineral Resources, Aleksandrov, USSR). Zh. Strukt. Khim., 9: 138 (Jan.-Feb. 1968). (In Russian).

Studies of $BaWO_4$ and $SrWO_4$ irradiated at 77°K revealed paramagnetic centers similar to those in $CaWO_4$ and molybdates ($CaMoO_4$, $SrMoO_4$, and $BaMoO_4$) with scheelite-type structure. The studies were carried out with a radiospectrometer at 9400 MHz and 77°K temperature. The EPR spectra of $BaWO_4$ and $SrWO_4$ consist of four anisotropic lines of equal intensity corresponding to four equivalent centers in the elementary cell. A hyperfine isotropic structure was observed in the ^{183}W isotope (nuclear spin I = ½, with 13% expansion) which appeared as a pair or double pair of satellites near the basic line. The $SrWO_4$ crystal has Hamiltonian spin constants: $g_1 = 2.014 + 0.001$, $g_2 = 2.025 + 0.001$, $g_3 = 2.001 + 0.001$, $A_1 = 12.4 \pm 0.5$, and $A_2 = 9.4 \pm 0.5$e. The crystal $BaWO_4$ constants are $g_1 = 2.014 \pm 0.001$, $g_2 = 2.025 \pm 0.001$, $g_3 = 2.000 \pm 0.001$, and ¼ $(A_1 + A_2) = 11 \pm 0.5$e. At room temperature the Hall centers and the violet color induced into the crystals by x irradiation disappeared within a few minutes. (R.V.J.)

27829 PULSE RADIOLYSIS OF PHENYLALANINE AND TYROSINE. Chrysochoos, J. (Michael Reese Hospital, Chicago). Radiat. Res., 33: 465-79(1968).

The pulse radiolysis method was used to investigate the initial radiolysis products of phenylalanine, p-hydroxyphenylpropionic acid, tyrosine, and polytyrosine in aqueous solutions. The transient spectra indicated that OH forms addition products with all 4 compounds and also attacks tyrosine, polytyrosine, and p-hydroxyphenylpropionic acid at the ionized phenolic OH group, giving phenoxyl derivatives. Evidence was obtained for the formation of phenoxyl by water elimination in near-neutral solutions of tyrosine and p-hydroxyphenylpropionic acid and the H-atom addition products in acidic solutions. The rate constants for the reactions of e^-_{aq} and OH are reported and compared with available literature values. (auth)

27830 RADIOLYSIS OF COMPOUNDS OF NOBLE METALS IN AQUEOUS SOLUTION. V. RADIOLYTIC REDUCTION OF SODIUM RUTHENATE. Haissinsky, Moise; Dran, Jean-Claude (Univ., Paris). J. Chim. Phys., 65: 321-5(Feb. 1968). (In French).

Sodium ruthenate was reduced in alkaline solution by γ rays to form a precipitate of Ru(IV) hydroxide. It was shown that RuO_4^- is an intermediate formed by oxidation. The proposed radiolytic mechanism accounted quantitatively for the results obtained in deaerated solutions. The reduction yield decreased with increasing solute concentration; this was attributed to the reaction of RuO_4^{--} with the ion-radical O^-, precursor of HO_2^-. The addition of NO_2^- increased the reduction yield since this ion competed with RuO_4^{--} for the O^- ions. The ratio of the rate constants $k(RuO_4^{--} + O^-)/k(NO_2^- + O^-)$ was evaluated at 7.6. (auth)

27831 TEMPERATURE DEPENDENCE OF EPR SPECTRA ON THE EPR γ IRRADIATED BUTYLBUTYRAMIDE. Kruglyak, Yu. A.; Kuts, V. S. (Kiev Inst. of Physical Chemistry). Zh. Strukt. Khim., 9: 33-8(Jan.-Feb. 1968). (In Russian).

EPR spectra of butyl butyramide were analyzed at −196 and −90°C, and the temperature dependence of the spectra on the changes in the potential barrier of slowed-down β-proton rotation in relation to their position in the nonionized molecule was studied. A model was developed describing the nonequivalence of β protons at low temperatures. The secondary spectrum moments were used for determining the distance between the minimum of delayed rotation potential and the corresponding space configurations of the $C_\beta H_2$ fragment in relation to the α proton. (tr-auth)

27832 STRAHLENCHEMIE. GRUNDLAGEN, TECHNIK, ANWENDUNG. (Radiation Chemistry. Principles, Techniques, and Uses). Kaindl, K.; Graul, E. H. (eds.). Strahlung und Isotope in Wissenschaft und Technik. Heidelberg, Dr. Alfred Huethig Verlag, 1967. 645p. DM 92.-.

Topics covered include: radiation and materials, radiation sources, chemical dosimetry, radiation chemistry of water, radiation chemistry of aqueous solutions, radiation chemistry of polymers, radiolysis of organic reactor coolants, radiation chemistry of frozen solutions, effects of radiation on inorganic solids, influence of radiation on catalysts, and the radiation chemistry of inorganic gases. (M.C.G.)

27833 ZUR VERNETZUNG VON POLYMEREN ZIMTSAEUREESTERN DURCH (UV-) LICHT UND γ-STRAHLUNG. (The Crosslinking of Cinnamic Acid Ester Polymers by UV Light and γ Radiation) Kroenert, Harald. Berlin, Technische Univ., 1967. 155p.

Thesis.

Photochemical studies on polycinnamates and ethyl cinnamate (EC) are reported. Light exposure of the EC used as model substance yields not only the polymerization previously known from the literature but, under corresponding light exposure conditions, favors dimerization. This result was explained as an intensity effect. The results of phosphorescent measurements on cinnamic acid, EC, and PVC polyvinyl cinnamate verify the hypothesis that the triplet state of the cinnamate group is responsible for the energy transfer in the sensitized crosslinking. PVC shows no photoconductivity. Comparative studies were made on the same compounds using γ radiation. The polycinnamates studied showed both crosslinking and depolymerization; the first reaction predominated as viscosity, swelling, and solubility measurements indicate. The possible radiation chemical products of the polymers, based on analysis of the radiolytic products and the uv and EPR spectra, are discussed. For the radiation chemical crosslinking of polymers, the aliphatic C=C bonds of the cinnamate groups appear to be decisive. The results obtained point to a protective effect of the cinnamate group in the polymers. Cinnamic acid can be dimerized radiation chemically, EC is polymerized. Both results confirm the assumption on the significance of the aliphatic C=C bonds for the crosslinking reactions of polycinnamates. (tr-auth)

27834 DONOR PROPERTIES OF TELLURIUM IN TRANSITIONAL METAL COMPLEXES. Tillay, Eldrid Wayne. Baton Rouge, La., Louisiana State Univ., 1967. 77p.

Thesis.

Investigations of the donor properties of diphenyl ditelluride, $C_6H_5-Te-Te-C_6H_5$, and analogous S and Se compounds, toward π-cyclopentadienyl transitional-metal substrates were carried out, and a number of new organometallic compounds was prepared. These new compounds include the first examples of Se and Te donor ligands bonded to π-cyclopentadienylmetal carbonyl substrates. Diphenyl ditelluride was reacted with π-cyclopentadienylmolybdenum tricarbonyl dimer, $[\pi\text{-CpMo(CO)}_3]_2$, to produce at least four distinguishable products. A monomer, $\pi\text{-CpMo(CO)}_3\text{TePh}$, was obtained at 25°C in benzene under the influence of low-energy irradiation. At 80°C (or 110°C) in refluxing benzene (or toluene) a dimer, $[\pi\text{-CpMo(CO)}_2\text{TePh}]_2$, resulted. Reaction of the Mo substrate with excess diphenyl ditelluride, or $[\pi\text{-CpMo(CO)}_2\text{TePh}]_2$ with diphenyl ditelluride, at xylene reflux temperature (139°C) produced an amorphous-like substance which has been formulated $[\pi\text{-CpMo(TePh)}_2]x$. The latter appears to be a polymer, but analogy with known sulfur-donor chemistry suggests a tetrabridged dimer (x = 2). An intermediate carbonylated species of undetermined structure was also observed in refluxing xylene when equimolar mixtures of the starting materials were used. Indirect evidence suggests this may be a trimer. The chemistry of diphenyl diselenide with $[\pi\text{-CpMo(CO)}_3]_2$ closely parallels that of its Te analog. Evidence was found for $\pi\text{-CpMo(CO)}_3\text{SePh}$, $[\pi\text{-CpMo(CO)}_2\text{SePh}]_2$, $[\pi\text{-CpMo(SePh)}_2]x$, and a possible trimer. The principal difference noted was the facile manner in which reactions involving diphenyl diselenide took place. Lower temperatures and less time were required for comparable reactions. Lower thermal stabilities of the carbonylated products involving Se appear to be associated with this phenomenon. The chemistry of diphenyl disulfide with the Mo substrate differs markedly from that of the diselenide and ditelluride. Evidence was found for a monomer, but it does not appear to possess the stability required for separation as a major product. No evidence was obtained to suggest that a dimer, $[\pi\text{-CpMo(CO)}_2\text{SPh}]_2$, was formed. However, an amorphous-like product, $[\pi\text{-CpMo(SPh)}_2]x$ and a possible trimer were readily formed under milder conditions than observed for the Se and Te reactions. Reactions of $\pi\text{-CpW(CO)}_3\text{H}$ with diphenyl dichalconides in refluxing solvents yielded monomers, $\pi\text{-CpW(CO)}_3\text{EPh}$ (E = Se, Te), and evidence was found to suggest that $\pi\text{-CpW(CO)}_3\text{SPh}$ existed. A dimer, $[\pi\text{-CpW(CO)}_2\text{TePh}]_2$, was apparently formed, but characterization was incomplete. The three dichalconides also were reacted with π-cyclopentadienylvanadium tetracarbonyl to produce, in each case, products formulated $[\pi\text{-CpV(EPh)}_2]x$ (E = S, Se, Te). No evidence was obtained to suggest the pathway for these reactions or the structure of the amorphous-like, highly insoluble products. (Disser. Abstr.)

27835 METHOD AND APPARATUS FOR PROMOTING A CHEMICAL REACTION BY IONIZING RADIATION. (to Japan Atomic Energy Research Inst.). British Patent 1,111,161. Apr. 24, 1968. Priority date Feb. 2, 1965, Japan.

A chemical reaction apparatus is described that uses a radio-

active inert gas as a reaction promoter. The radioactive gas is contained in a radiation source gas and is circulated through the reactants in the reaction vessel from a storage tank. The reaction apparatus also includes a circulation pump, a vacuum pump, an exhaust pump, electromagnetically-operated valves and flow meters, and pipe lines connecting all these members. The source gas is circulated at a rate such as to initiate the reaction. Remote control means are provided for operating the apparatus. (B.L.M.)

27836 THE PREPARATION OF STERILE, LOW-TRITIUM ^{18}F AND RADIOCHEMICAL SEPARATIONS USING HYDROGEN bis(2-ETHYLHEXYL) PHOSPHATE AND K X-RAY YIELDS FROM THE FISSION OF ^{233}U, ^{235}U, AND ^{239}Pu. LaFleur, Philip DeLos. Ann Arbor, Mich., Univ. of Michigan, 1967. 130p.

Thesis.

A method was developed for the preparation of sterile, low-tritium ^{18}F. The ^{18}F is produced by the reactions $^{6}Li(n,t)^{4}He$, $^{16}O(t,n)^{18}F$. The ^{18}F is purified by co-precipitation of the carrier-free fluoride on lanthanum hydroxide, dissolution of the hydroxide in dilute acid, and removal of cationic impurities by passing the solution through a cation-exchange column. The yield of ^{18}F averaged 75%. The purity of the final sample with respect to γ emitting impurities was greater than 99.9%. The average ^{3}H content was 0.77 μCi ^{3}H per 100 μCi of ^{18}F. The product is sterile and free of pyrogens. The application of hydrogen bis (2-ethylhexyl) phosphate to the radiochemical isolation of molybdenum by liquid-liquid extraction was studied. The isolation of ^{99}Mo from mixed fission products was accomplished. Chemical yields average 97.8 ± 0.3% and the radiochemical purity was greater than 99%. Six samples may be prepared in less than 90 min. The method was applied to the rapid isolation of Mo fission products from the gross fission mixture so that Mo isotopes of mass number greater than 102 may be studied. The Mo fraction may be obtained in approximately 90 sec with high radiochemical purity. Gamma rays ascribed to Mo isotopes and their half-lives observed in the rapidly decaying mixture were: 190 keV, 72 ± 6 sec; 500 keV, 1.9 ± 0.4 min; 585 keV, 71 ± 6 sec; and 710 keV, 1.4 ± 0.3 min. Evidence was sought for the existence of a 5.3-hour isomer of ^{102}Mo in the 47-MeV proton fission of U and Th. The isomer was not observed. The cumulative fission yield of this isomer is less than 10^{-2}% in the 47-MeV proton fission of U and Th. The application of hydrogen bis (2-ethylhexyl) phosphate to the rapid isolation of Ce, Yt, and Zr fission products is also discussed. The yield of K x rays coincident with the slow neutron fission of ^{233}U, ^{235}U, and ^{239}Pu was determined. For ^{233}U, 0.11 ± 0.02 x rays from the light fission fragment group and 0.19 ± 0.02 x rays from the heavy group were observed per fission. For ^{235}U the yields were 0.13 ± 0.02 x rays from the light group and 0.21 ± 0.03 x rays from the heavy group. In the case of ^{239}Pu the yields were 0.18 ± 0.02 x rays from the light group and 0.21 ± 0.03 x rays from the heavy group. (Disser. Abstr.)

27837 EFFECT OF X RADIATION UPON THE ELECTROPHORETIC MOBILITY OF SILVER IODIDE COLLOIDS. Spivack, Mark Andrew. New York, Columbia Univ., 1966. 76p.

Thesis.

The change in the electrophoretic mobility of negative AgI sols was studied as a function of dose of 50 keV x rays. The change in mobility almost directly reflects the growth (and decay) of iodine in an iodide solution; the change is caused by the preferential adsorption of iodine over iodide at the particle surface. Contrary to previous findings, results indicate that iodine is formed, at low doses, in dilute (less than 10^{-3} M) deaerated KI solutions, however, further irradiation reduces it back to iodide by radiation produced hydrogen. (Disser. Abstr.)

27838 NUCLEATION AND PRECIPITATION OF LITHIUM IN SILICON. Ferman, John Walter. Minneapolis, Univ. of Minnesota, 1967. 120p.

Thesis.

A study of Li precipitation in low-O-content, monocrystalline Si was conducted to learn the role of initial Li concentration, precipitation temperature, pre-annealing temperature, and γ irradiation (^{60}Co) on the kinetics of precipitation. Si wafers were Li saturated by diffusion at temperatures from 600 to 730°C. Precipitation at temperatures of 94 to 157°C was followed by a potentiometric technique. In some cases, pre-annealing at temperatures from 800 to 1300°C preceded Li saturation. Gamma (^{60}Co) irradiation was conducted at room temperature. Visual and infrared transmission microscopy were employed to determine precipitate particle distribution, shape, and number density. The change in Li content, calculated from electrical resistivity with time was analyzed in light of diffusion-limited precipitation theory. After about half of the initial Li content had precipitated the Li concentration decreased exponentially as $-t/\tau$ where τ is given by $\tau^{-1} = AD(vC_o)^{\frac{1}{3}}N_p^{\frac{1}{3}}$ where A = shape factor, D = Li diffusion coefficient, v = precipitate volume/Li atom, C_o = initial Li content, and N_p = number density of precipitate particles. Empirically, τ^{-1} was found to be proportional to D at the precipitation temperature for both C_o and N_p constant and to be consistent with $C_o^{\frac{1}{3}}$ for constant precipitation temperature. Gamma irradiation increased τ^{-1} moderately whereas high temperature pre-annealing increased τ^{-1} strongly. Microscopy revealed randomly distributed precipitate particles, which appeared to be disks lying on {111} matrix planes in as-grown Si but were probably spheres in pre-annealed Si. From an estimate of the O content of the Si (~5×10^{15}/cc) and by means of the observation by Pell that $\tau^{-1} \alpha [O]^{\frac{1}{3}}$, it is reasoned that N_p depends on the O content of the crystal and on the pre-annealing temperature according to $N_p = 800[O] \exp(-1.67\ eV/kT)$. This equation is in substantial agreement with τ^{-1} values obtained from pre-annealed, high O content Si. Arguments are advanced to support a heterogeneous nucleation model wherein Li segregates into a diffuse atmosphere about O-vacancy pairs. The O-vacancy binding energy is estimated to be about −0.56 eV. Lithium-interstitial O pairs are known to be strongly bound with an energy of about −0.52 eV, whereas the effective binding energy between Li and O vacancy pairs appears to be about 0.04 eV (~kT_{prec}). These inferences are in harmony with the observations by Weltzin and Swalin for the Ge−Li system. An approximate application of Debye-Hückel theory indicates that electrostatic forces alone could cause ~75 Li ions (+e) to segregate about an O-vacancy pair ion (−e). The mean electrostatic binding energy is small and the diffuse segregate could collapse into a nucleus within one second at the precipitation temperature. From the supersaturation ratio of Li and a crude estimate of particle/matrix interfacial energy, homogeneous nucleation theory would imply that about 3 to 40 Li atoms would be required to form a nucleus. (Disser. Abstr.)

27839 HETEROGENEOUS SYNTHESIS OF AMMONIA IN THE PRESENCE OF GAMMA RADIATION. Snyder, James Langley. Ithaca, N. Y., Cornell Univ., 1967. 198p.

Thesis.

The effect of ^{60}Co γ radiation on the synthesis of ammonia in the presence of two types of solids was investigated. The solids used were a typical commercial synthesis catalyst and several commercial aluminas. Preliminary experiments using stoichiometric gas mixtures showed that the rate in the homogeneous system was 8.6×10^{-6} moles ammonia/liter, hr at 250 psig, 25°C, and a dose rate of 1.8×10^{6} RADS/hr. This corresponded to a G for the synthesis reaction of 0.73, which agreed with published figures. Dose rates were measured with a Fricke ferrous sulfate dosimeter. The heterogeneous experiments were conducted in a flow reactor at elevated temperatures and pressures. Successive experiments at 750 and 1000 psig, and 6.5×10^{5} RADS/hr showed that the γ radiation had no effect on the reaction over the commercial synthesis catalyst. Conversely, experiments with alumina showed a definite beneficial effect. Although no NH_3 was produced in the absence of radiation, or by pre-irradiation of the alumina, concurrent irradiation of 6.4×10^{5} RADS/hr produced synthesis rates up to 100 times the corresponding rates in the homogeneous system. A maximum rate limitation, which was a function of the temperature, pressure, alumina specific surface area, and gas composition was encountered. In stoichiometric gas mixtures this limitation occurred on aluminas with area of 210 m^2/g or higher at 400°C and 700 psig. For lower surface area aluminas the critical temperature increased, reaching 500°C for 0.5 m^2/g. At temperatures and pressures below these critical values the system responded normally. The synthesis rate followed a second order pressure dependence and exhibited an energy of activation that decreased from 34 to 25 kcal/g mole as the alumina surface area increased from 0.5 to 210 m^2/g. At constant pressure the rate was a linear function of the alumina specific surface area. However, the rates at all pressures extrapolated to zero at 56 m^2/g thus indicating positive values at zero surface area. Varying the pH of the alumina had no effect on the reaction. The same rate limitation was encountered in experiments with the 210 m^2/g alumina and a 3:1 N:H mixture, although at the lower temperatures and pressures the pressure dependence shifted to ½ and the activation energy decreased to 6 to 7 kcal/mole. Similar experiments with a 1:1 N:H mixture showed a second order pressure dependence and an activation energy of 66 kcal/g mole. However, the critical temperature shifted from 400 to 380°C and the critical pressure from 700 psig to above 1000 psig, the upper experimental limit. Comparison of the results with the three gas mixtures indicated the true pressure dependence of the synthesis rate was $(P_{N_2})^{1.5}(P_{H_2})^{0.5}$. These results are explained in terms of an energy transfer mechanism involving the alumina and the N and H molecules chemisorbed on its surface. The maximum rate limitation and the results of the experiments with the magnetite catalyst are explained by this mechanism. (Disser. Abstr.)

27840 DIRECT AND RARE-GAS SENSITIZED RADIOLYSIS OF LIQUID PROPANE. Koob, Robert D. Lawrence, Kan., Univ. of Kansas, 1967. 145p.

Thesis.

A study of the γ radiolysis of liquid propane was undertaken. A principal objective of this study was to see to what extent the mechanisms found for gas-phase radiolysis of propane can be extended to liquid-phase radiolysis. Of primary interest was the establishment of ionic reactions in the liquid hydrocarbon. To this end radical scavengers and rare gas sensitizers were employed. Direct evidence for the presence or absence of bimolecular reactions in the liquid was obtained by analysis of irradiated mixtures of perproto- and perdeuteropropane. Gas chromatography was used both to purify the reactant propane and to analyze the irradiated sample. Mass spectrometry was employed as an analytical tool for determining the relative amount of various isotopic distributions of products formed in the radiolysis of systems such as $C_3H_8-C_3D_8-O_2$. The total yield of products decreased with a change from gas to liquid and also decreased with decreasing temperature. The distribution of isomeric hexanes changed in such a way as to imply that normal propyl radicals increase in importance relative to isopropyl radicals. The product distributions in the various rare gas-sensitized systems are markedly different. The most striking is the system $Ar:C_3H_8:O_2$ where two products, methane and ethane, account for greater than 80% of the total product observed. As the ionization potential of the sensitizing rare gas decreases (Ar, Kr, Xe) the relative contributions to the product spectrum of ethylene and propylene increase. The results of both the scavenged and unscavenged direct radiolysis of liquid propane are consistent with the general conclusion that the decomposing moiety has a lower average excitation energy in the liquid than in the gas phase. This implies that the primary species in propane radiolysis exists for a period longer than the time required for some collisional deactivation. Furthermore, several more specific effects were observed. Many of these are consistent with work of earlier investigators. D/C increased with the change to liquid phase and with decreasing temperature. Decreasing temperature reduced the importance of H atom abstraction as a mode of reaction in the liquid. Propyl ions and propane ions may be important precursors of propyl radicals in the liquid. Ion decomposition is much more important in the direct liquid-phase radiolysis than was predicted from earlier pressure dependency studies. The data in rare gas-sensitized liquid propane experiments led to the conclusions that the $Ar-C_3H_8$ radiolysis system is dominated by the reactions of ions and their associated fragments; in the $Kr-C_3H_8$ system neutral molecule decomposition is an important mode of product formation but that ion associated reactions still predominate; and in the $Xe-C_3H_8$ system neutral molecule dissociations predominate in the formation of fragmentation products, but that $C_3H_7^+$ and $C_3H_8^+$ ions have become important as propyl radical precursors. (Disser. Abstr.)

27841 THE STRUCTURE OF INORGANIC RADICALS. An Application of Electron Spin Resonance to the Study of Molecular Structure. Atkins, P. W.; Symons, M. C. R. New York, Elsevier Publishing Company, 1967. 280p. $21.75.

Topics covered include: an introduction to electron spin resonance, formation and trapping of radicals (including radiolysis), trapped and solvated electrons, atoms and monoatomic ions, diatomic radicals, triatomic radicals, tetra-atomic radicals, penta-atomic radicals, and summary and conclusions. Appendixes include: the language of group theory, the spin Hamiltonian, calculation of g-values, determination of spin-density distribution and bond angles, and analysis of electron spin resonance spectra. (M.C.G.)

Radiochemistry

Refer also to abstract 27741.

27842 THE SIMULTANEOUS DETERMINATION OF RUTHENIUM AND OSMIUM BY A RADIOCHEMICAL METHOD. Chung, K. S.; Beamish, F. E. (Univ. of Toronto). Anal. Lett., 1: No. 2, 45-52(Nov. 1967).

A simple radiometric procedure is proposed for the simultaneous determination of microgram amounts of Ru and Os by use of neutron activation. About 5 mg of purified sponge of both metals was irradiated for 3 days at a neutron flux of $\sim 5 \times 10^{12}$ n/cm^2/sec. After a cooling period of about 5 days, the irradiated materials were thoroughly mixed with about 0.5 g of sodium peroxide in a Ni crucible and fused. The fused mass was disintegrated first with water and then with 1N sulfuric acid. The tracer solution was diluted to 100 ml with 5N sulfuric acid solution. The tetroxides of both metals were collectively distilled and then determined directly by measuring the photopeak areas of ^{191}Os and ^{103}Ru at 45 and 498 keV respectively. The effect of Compton continua was negligible. The radiation measurements were made using 3 × 3 in. NaI(Tl) detector in conjunction with a 400-channel analyzer. (BBB)

27843 CHEMICAL EFFECTS DURING BETA DECAY OF ^{239}U, OCCURRING IN SOLUTIONS IN THE URANYL FORM. Peretrukhin, V. F.; Krot, N. N.; Glazunov, M. P.; Gel'man, A. D. Radiokhimiya, 9: 665-8(1967). (In Russian).

The distribution of ^{239}Np by valence during its accumulation at 0°C from ^{239}U, introduced in the uranyl composition, was determined in 1N $HClO_4$, 1N H_2SO_4, diethyl ether, and TBP. In these media Np is accumulated chiefly in the tetravalent state. It was established that the distribution of various valence forms of ^{239}Np is the result of nuclear-chemical transformations during β decay and is not altered by chemical reactions of cold Np ions. It was found that the high yield of tetravalent Np cannot be explained by recoil processes after emission of β particles and γ rays appears as the result of internal conversion and electron motion during β decay of ^{239}U. (tr-auth)

27844 EMISSION SPECTRA EXCITED IN CERTAIN METALS BY THE β PARTICLES OF ^{14}C AND ^{147}Pm. Kryukov, S. N.; Karamanova, Zh. S. (Moscow Univ.). Vestn. Mosk. Univ., Ser. II. Khim., No. 3, 106-8(May-June 1967). (In Russian).

Even though the characteristic x radiation excited by β particles is used for analytical determinations, the overall potential field of application of this method has not yet been evaluated; therefore, the laws governing the excitation of x radiation by the β particles of ^{14}C and ^{147}Pm in metals with an atomic number from 40 to 82, i.e., Zr, Mo, Ag, Cd, Sn, Ta, Pt, and Pb was investigated. The thickness of the pure specimens exceeded the total absorption length. The measurements were carried out in a 90° reflection geometry between the emitter and the detector, using a scintillation counter, a 100-channel analyzer and an amplifier for studying the spectra obtained with the help of the 38.8 μCi/g and 5 μCi ^{14}C and ^{147}Pm sources, respectively. The results revealed a characteristic peak of the k radiation; no bremsstrahlung peak was noted. The correlation between and the atomic number was also determined. The results indicated that it might be possible to use the dependence of the intensity of the k line on the atomic number for analytical purposes. (TTT)

Separation Processes

Refer also to abstracts 27529, 27574, 27575, 27609, 27620, 27663, 27736, 27738, 27808, 27836, 27962, 28198, 28214, 28473, and 28783.

27845 (CEA-N-816, pp 150-276) ETUDE DES PROCEDES DE TRAITEMENT DES COMBUSTIBLES IRRADIES PAR VOIE AQUEUSE-LABORATOIRE. (Study of the Procedures for Processing by Aqueous Methods-Laboratory). (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). (In French).

Developments are reported for studies on: natural U fuels, including adjustment of Pu valence; stability of solutions of fission products containing Mo; problems related to inert materials in fuels; and solubility of TBP in water and partition between aqueous solutions and dodecane; slightly enriched uranium oxide fuels, including flow-sheet treatment calculation and experimental conditions; code-contamination in first extraction cycle; partition in second extraction cycle; and third Pu extraction cycle; highly enriched U alloy fuels; Pu fuels from breeder reactors, including Rapsodie irradiated fuel treatment workshop; Pb and Sb behavior in nitric solutions; AT1 process experimentation in shielded cells; Pu purification by tridodecylamine extraction, including chemical stability of tridodecylamine; hydrolysis of salts of tri- and didodecylamine; effects of DBP on U extraction; U behavior during sulfonitric extraction of Pu; distribution of U(IV) between tridodecylamine and aqueous nitric acid solutions; recovery of Pu from residual solutions of analysis; and recovery of Pu contained in the mother liquor from precipitation of plutonium oxalate; and re-extraction of some actinides contained in organic solvent by nitrogen dioxide. (P.C.H.)

27846 (CEA-N-816, pp 277-323) ETUDE DES TRAITEMENTS PAR VOIE AQUEUSE-ATELIER PILOTE. (Study of the Procedures for Processing by Aqueous Solutions-Pilot Plant). (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). (In French).

Developments are reported for studies on: steam distillation of TBP in aqueous phase reextraction; treatment of irradiated fuel batch consisting of Mo-U rods by anti-diffusion barrier; sampling of irradiated fuels treatment pilot plant; and laboratory studies. (P.C.H.)

27847 (CEA-N-816, pp 324-58) ETUDE DES PROCEDES DE TRAITEMENT PAR VOIE SECHE. (Study of the Procedures for Processing by Dry Methods). (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). (In French).

Developments are reported for studies on: volatilization of halogenides; treatment of U–Zr and U–Al alloys; separation of U–Pu from their hexafluoride mixture; Mg decladding by melting at high temperatures; and dry electrolysis at high temperatures. (P.C.H.)

27848 (CEA-N-816, pp 359-414) PREPARATION ET ETUDE D'ISOTOPES D'ELEMENTS ACTINIDES. (Preparation and Study of Isotopes of Actinide Elements). (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). (In French).

Developments are reported for studies on: preparation of ^{237}U; separation of Np–Pu; recovery of Np on semi-industrial scale; preparation of metallic Np; preliminary studies on countercurrent extraction of irradiated Pu; separation of actinides from lanthanides in nitric media; shielded cells equipment; electrolytic pumps; and special mixer-settlers. (P.C.H.)

27849 (CEA-N-816, pp 415-80) ETUDE DE LA VITRIFICATION DES SOLUTIONS CONCENTREES DE PRODUITS DE FISSION. (Study of the Vitrification of Concentrated Solutions of Fission Products). (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). (In French).

Developments are reported for studies on: composition of aluminous glasses; stability of fluorides during vitrification; vitrification by the pot process; separation of Hg from Al–U alloys dissolution liquors; vitrification of fission products from treatment of slightly alloyed uranium fuels; model of the vitrification pilot plant at Marcoule; continuous calcination of fission product solutions; and elaboration and storage of blocks of active glass. (P.C.H.)

27850 (CEA-N-816, pp 80-9) TRAITEMENT DE L'URANIUM. (Processing Uranium). (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). (In French).

Developments are reported for studies on: use of bacteria for treating ores; treatment of enriched uranium; and new techniques for treatment of uranium. (P.C.H.)

27851 (CEA-N-816, pp 66-79) TRAITEMENT DES EFFLUENTS MOYENNEMENT ET FAIBLEMENT ACTIFS. (Processing Moderately and Weakly Active Effluents). (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). (In French).

Developments are reported for studies on: decontamination with surface-active agents; ion exchange decontamination; chemical treatments by precipitation; liquid effluent treatment by evaporation; and working of bacteria in the effluents treatment. (P.C.H.)

27852 (EURAEC-2011) REPROCESSING OF IRRADIATED FUELS. Annual Report, July 1966–June 1967. (Centre d'Etude de l'Energie Nucleaire, Brussels (Belgium)). Contracts 006-65-7-RCIB(RD); 016-65-1-RAP-B. 33p. (EUR-3797). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

Basic research has been performed in the following areas: selective volatilization of uranium in the presence of plutonium; the influence of the density and the plutonium content of the oxides on the volatilization rate of uranium; formation and composition of gaseous by-products resulting from the reaction of chlorine trifluoride and chlorine monofluoride with the U–O–F compounds; and the thermodynamics of plutonium fluoration reactions. The study of chemical decladding was continued. Autoregulation of the reaction occurred when AISI-347-canned elements were treated with a mixture of oxygen and hydrogen fluoride; during these experiments caking could generally be avoided by prefluoration of the alumina. Pulverization experiments were performed on 4-kg quantities of UO_2 pellets. It was concluded that stainless steel decladding, using $HF + O_2$ mixtures, is feasible and that pulverization of the UO_2 fuel is satisfactory. A systematic study was performed on the volatilization of uranium, using chlorine trifluoride and chlorine monofluoride and different uranium compounds. The next step in the development was the study and construction of a large unit for testing the procedures of chemical decladding, fuel pulverization, and volatilization of UF_6 using nonirradiated fuel bundles. A semi-pilot facility (SPC) was constructed and the first tests of the installed equipment were started. In the plutonium facility (SPu) some active experiments were performed, mainly in view of testing the degree of selectivity of ClF_3 for uranium and of establishing a plutonium balance. The volatilization study of some selected fission products and of neptunium was completed at tracer level. (auth)

27853 (INP-591/C) EKSTRAKCJA STATYCZNA I DYNAMICZNA NIEKTORYCH METALI W UKLADACH CZTEROBUTYLOHIPOFOSFORAN–CZTEROBUTYLOPIROFOSFORAN (1:1) ORAZ CZTEROBUTYLOPIROFOSFORAN/KWASY MINERALNE. (Static and Dynamic Extraction of Some Metals in the Systems Tetrabutylhypophosphate–Tetrabutylpyrophosphate (1:1) and Tetrabutylpyrophosphate/Mineral Acids). Mikulski, Jan (Institute of Nuclear Physics, Krakow (Poland)). Feb. 1968. 82p. (In Polish).

The distribution coefficients of the following ions: Zr^{+4}, Hf^{+4}, Th^{+4}, Nb^{+5}, Ta^{+5}, Pa^{+5}, $U^{+4,+6}$, $Np^{+4,+6}$, and $Pu^{+4,+6}$ were determined using TBHP–TBPP (1:1) and TBPP in the static extraction. Using the dynamic extraction in the system TBHP–TBPP (1:1)–HNO_3 some rare earths and transuranium elements were separated. The distribution coefficients of californium, fermium, and mendelevium were determined from the chromatographic data. (auth)

27854 (IS-T-224) OPTIMIZATION OF A SOLVENT EXTRACTION PLANT TO PROCESS MONAZITE RARE EARTH NITRATES. Sebenik, Roger Frank (Ames Lab., Iowa). Feb. 1968. Contract W-7405-eng-82. 64p. Dep. CFSTI.

Thesis.

A computer program for the IBM-360 series digital computer has been written to calculate the composition of streams, the size and cost of process units, and the return on investment of a solvent extraction plant to recover $La(NO_3)_3$ from a cerium-free monazite rare earth feed when the production rate in tons of rare earth feed per day and six operating variables are specified. Equilibrium data for the $La(NO_3)_3$–$Pr(NO_3)_3$–$Nd(NO_3)_3$–$Sm(NO_3)_3$–HNO_3–H_2O–TBP system and material balance calculations are used to make stage-by-stage calculations in the extractor. The program was used to develop an iterative optimization procedure to obtain the maximum return on investment for a plant that produces a 99.9% $La(NO_3)_3$ product at a 99.0% recovery. The procedure was efficient, converging to the optimum with a maximum of six steps for five starting points tested. (auth)

27855 (ISO-SA-22) PLASTICS IN A PLUTONIUM SCRAP RECOVERY PLANT. Bruns, L. E. (Isochem Inc., Richland, Wash.). June 30, 1966. Contract AT(45-1)-1851. 20p. (CONF-660706-2). Dep. CFSTI.

From 3rd Washington State Univ. Pacific Northwest Plastics Workshop Meeting, Richland, Wash.

A plutonium scrap recovery plant is briefly reviewed, stressing the uses of corrosive mediums such as nitric acid-fluoride systems at ambient and elevated temperatures. Uses of plastics in all phases of the operation are discussed. In auxiliaries, polychloroprene is used for hood gloves, and copolymers of vinyl acetate and vinyl chloride are used for plastic bags. Polyvinyl chloride (PVC) and polyvinylidine fluoride (PVF_2) are valuable as corrosion resistant piping. Pipes lined with tetrafluoroethylene (TFE) and fluoroethyleneпropylene (FEP) are used as dissolvers and leach tanks. PVF_2 spacers and flanges are used throughout the facility because of their excellent corrosion resistance, as well as negligible cold flow characteristics. TFE impregnated with asbestos and fluoroelastomers are valuable as gasketing. Recent developments of plastics and applications of plastics were instrumental in the successful startup and continued operation of the plutonium scrap recovery plant. Plastics can find even wider use if means can be found to broaden the chemical resistance, increase the permissible temperature range, increase resistance to radiation, and decrease the cost relative to metals. (auth)

27856 (K-1738) ORGDP FUEL REPROCESSING STUDIES. Summary Progress Report, January–June 1967. Pashley, J. H.; Schappel, R. B. (Oak Ridge Gaseous Diffusion Plant, Tenn.). May 9, 1968. Contract W-7405-eng-26. 101p. Dep. CFSTI.

Studies are being made of a group of processes aimed at purifying and recovering uranium and plutonium from spent nuclear reactor fuels. The program includes two main phases: preparation of conceptual plant studies with concomitant definition of problem areas associated with the process and technology and plant design; and component development, including scale-up and testing of crucial process equipment and auxiliaries. Topics covered include: the status of the current low-enrichment fuel flow sheet studies, including the systems analysis project and conceptual plant studies; computation of properties of irradiated fuels; effects of contamination of plutonium product with ruthenium; criticality calculations; semiworks interhalogen recycle system design; process and reactor studies, including semiworks plant operation and bench-scale elutriation tests; sampling experiments; outlet gas filter studies; connector evaluation; uranium purifica-

tion in a sorption-desorption system employing sodium fluoride; testing of the ORGDP designed peripheral compressor; and fluorination of Argonne National Laboratory reactor bed material for use in the Oak Ridge National Laboratory waste treatment experiments. (auth)

27857 (KFK-680) DIE VERTEILUNG DER METALL-NITRATE IM SYSTEM $Pu(NO_3)_4$–$UO_2(NO_3)_2$–HNO_3/TBP–DODECAN. (Distribution of Metal Nitrates in the System $Pu(NO_3)_4$–$UO_2(NO_3)_2$–HNO_3/TBP–Dodecane). Baumgaertel, G.; Ochsenfeld, W.; Schmieder, H. (Kernforschunszentrum, Karlsruhe (West Germany). Institut fuer Heisse Chemie). Dec. 1967. 24p. (In German). (EUR-3707). Dep.

Experimental distribution data were determined for the extraction system $Pu(NO_3)_4$–$UO_2(NO_3)_2$–HNO_3/TBP–dodecane in a wide uranium and plutonium concentration range. With the help of this data the distribution coefficients of U(VI) and Pu(IV) in TBP–dodecane could be determined with good accuracy. The equations developed were also used in stage calculations for extraction columns for reprocessing fast-breeder fuels. (tr-auth)

27858 (K-L-1780(Pt.24)) ORGDP FUEL REPROCESSING STUDIES. Progress Report for Period Ending December 31, 1967. Pashley, J. H. (Oak Ridge Gaseous Diffusion Plant, Tenn.). Apr. 5, 1968. Contract W-7405-eng-26. 16p. Dep. CFSTI.

A close-out plan for the ORGDP fluoride volatility program was adopted. New runs were made in the semiworks plant to study the influences of pressure and HCl pretreatment of UO_2 on the elutriation of U_3O_8 during oxidation. Filter studies were made in the filter test loop with multicycle exposures to volatility process corrosive atmospheres and continued operation of the peripheral compressor. Conceptual studies of a plant for volatility processing of light water reactor fuels are discussed. (M.C.G.)

27859 (NP-17418) MULTI-PURPOSE PLANT FOR THE RECOVERY OF NEPTUNIUM AND OTHER ISOTOPES. Rodger, Walton A.; Reese, Stanton L.; Stanton, Shelton S. (Nuclear Safety Associates, Bethesda, Md.). Jan. 1967. 135p.

For New York State Atomic and Space Development Authority, New York.

The technical and economic feasibility of the extraction of neptunium and other isotopes of interest from the waste streams of the West Valley Processing Plant is discussed. Selected plant processes, waste products, neptunium recovery processes, recovery processes for other isotopes, waste handling and utility services for multipurpose plant, description of the plant, capital costs, and operating costs are considered. (M.C.G.)

27860 (NYO-1922-43) PROGRESS REPORT ON RESEARCH ON COMPLEXES IN SOLVENT EXTRACTION CHEMISTRY. Li, Norman C. (Purdue Univ., Lafayette, Ind. Dept. of Chemistry). Apr. 1968. Contract AT(30-1)-1922. 11p. Dep. CFSTI.

Research progress is reported on the following topics: synergism and destruction of synergism with several β-diketones and neutral adducts, proton magnetic resonance studies of water as hydrogen donor to tributyl phosphate, chloroform as a hydrogen donor to some organophosphorus compounds and tertiary alkylamines, x-ray and Moessbauer studies, and extraction of metal complexes containing long-chain tertiary alkylamines. (M.C.G.)

27861 (ORNL-4204, pp 60-7) MOLTEN-SALT REACTOR PROCESSING. McNeese, L. E. (Oak Ridge National Lab., Tenn.).

The relative volatilities of several rare-earth fluorides (REF's) in the ternary system LiF–BeF_2–REF were measured; all except PrF_3 were lower in this system than in the binary system LiF-REF. (auth)

27862 (ORNL-4204, pp 4-15) CHEMICAL ENGINEERING RESEARCH. (Oak Ridge National Lab., Tenn.).

The 18-stage prototype solvent-extraction stacked-clone contactor, which was designed for radiochemical use, was further tested with the light phase continuous by maintaining the interface either within the contactor or in an external settler. Operation with an internal interface reduces solution inventory, but is not practical with certain chemical systems. Batch dispersion break times were measured for several systems that have potential for light-phase-continuous operation. The break time varied greatly with the phase ratio. When measured at the proper phase ratio, break times of very finely divided dispersions can be used to aid in the detection of chemical systems that will exhibit significant flows in the stacked-clone contactor. (auth)

27863 (ORNL-4204) UNIT OPERATIONS SECTION QUARTERLY PROGRESS REPORT, APRIL-JUNE 1967. Whatley, M. E.; Haas, P. A.; McNeese, L. E.; Ryon, A. D.; Suddath, J. C.; Watson, C. D. (Oak Ridge National Lab., Tenn.). May 1968. Contract W-7405-eng-26. 71p. Dep. CFSTI.

Research progress is reported under the following topics: chemical engineering research, engineering separation of macromolecular biological substances, sol-gel process development, thorium fuel-cycle studies, power reactor fuel processing, fast-breeder reactor fuel processing, and molten-salt reactor processing. Separate abstracts were prepared for each topic. (M.C.G.)

For abstracts of individual sections see: 27861, 27862, 27864–27867, and 28887.

27864 (ORNL-4204, pp 16-21) ENGINEERING SEPARATION OF MACROMOLECULAR BIOLOGICAL SUBSTANCES. Hancher, C. W.; Weeren, H. O. (Oak Ridge National Lab., Tenn.).

A mixed tRNA feed was reprocessed by isopropanol precipitation to remove DNA. The reprocessed feed was then treated with DEAE (diethylaminoethyl cellulose) in a column to remove ribonuclease. A new form of DEAE and new operating techniques made this operation practical. A number of runs were made, using isopentyl acetate reversed-phase columns, to determine the effects of column support material, type and lot of amine that was used as the organic phase, and the source of the mixed tRNA feed. (auth)

27865 (ORNL-4204, pp 46-51) POWER REACTOR FUEL PROCESSING. (Oak Ridge National Lab., Tenn.).

The 250-ton shear was modified prior to shearing 10- by 10-in. power-reactor fuel prototypes; the operability of this new version was tested, on a preliminary basis, by shearing oak timbers. The use of a hacksaw for reducing large graphite fuel blocks to a feed that is suitable for a hammer mill or a roll crusher was successfully demonstrated. The high-pressure hydraulic system was installed and is being tested. (auth)

27866 (ORNL-4204, pp 40-5) THORIUM FUEL-CYCLE STUDIES. Haas, P. A. (Oak Ridge National Lab., Tenn.).

Numerous improvements were made in the equipment in the Coated Particle Development Laboratory to eliminate operational upsets and to improve the clarity of the 2-ethylhexanol. Four pumps and three control valves were eliminated, and modifications were made to prevent vessel overflows. (auth)

27867 (ORNL-4204, pp 52-9) FAST-BREEDER REACTOR FUEL PROCESSING. Watson, C. D.; West, G. A. (Oak Ridge National Lab., Tenn.).

A conceptual layout of the mechanical head-end procedure (disassembly, canning, shearing, and leaching) needed for reprocessing fast-breeder fuels was prepared. This layout is the basis for an economic study of the costs of reprocessing short-cooled fuels. A model for handling the fuel pins was built and operated to verify its feasibility. Temperatures to be encountered during disassembly and shearing were estimated by using the computer code BIGDEAL. (auth)

27868 EXTRACTION OF RARE-EARTH ELEMENTS WITH NAPHTHENIC ACIDS. Alekperov, R. A.; Geibatova, S. S. (Inst. of Inorganic and Physical Chemistry, Baku). Dokl. Akad. Nauk SSSR, 178: 349-51(Jan. 11, 1968). (In Russian).

Extraction properties of naphthenic acids for individual rare earth metals were studied considering the distribution of the initial metal concentration in the aqueous phase and the influence of the content of the aqueous solutions. Data obtained showed that the pH for the extraction of rare earths decreased with the transition from La to Eu and increased from Gd to the end of the series (La pH 3.97, Ce 3.89, Pr 3.78, Nd 3.74, Pm 4.1, Sm 3.73, Eu 3.62, Gd 3.76, Dy 3.76, Ho 3.97, Er 3.84, Tm 3.92, Yb 4.02, and Y 4.30). The maximum difference of $pH_{0.5}$ between two neighboring elements was 0.15 and the minimum 0.02. (R.V.J.)

27869 EXTRACTION OF RUTHENIUM(III) BY LONG-CHAIN AMINES FROM SULPHURIC ACID SOLUTIONS. Shanker, R.; Venkateswarlu, K. S.; Shankar, J. (Bhabha Atomic Research Centre, Bombay). J. Less-Common Metals, 15: 75-88(May 1968).

Results of studies on the extraction of Ru(III) from sulfuric acid solutions are reported. The extraction decreases in the order primary amines > secondary ≥ tertiary amines. Within the group of tertiary amines, studies with tri-n-hexylamine, tri-n-octylamine, triisooctylamine, and tri-n-nonylamine show that the extraction of Ru(III) decreases with increasing chain length and that branching in the amine increases the extraction. Aggregation of amine sulfate is shown to be responsible for unexpected mass action relationships. The organic diluent used was also varied to study the effect of dielectric constant as well as of the chemical nature of the diluent. Maximum extraction was observed when nitrobenzene is used as the diluent. Infrared spectra of the organic phase in the N–N stretching and N–H deformation regions indicated salt formation on equilibration with sulfuric acid. The spectra also showed that salt formation is high with primary

amines, corroborating the high extractability observed. The spectra in different diluents indicate that the chemical nature of the diluent influences the extent of salt formation, which leads to changed extraction. Mixture of secondary amine and tri-iso-octylamine gave enhanced extraction as compared to the individual components. On the other hand, increase in sulfuric acid or sulfate ion concentration in the aqueous phase decreased the extraction of Ru(III), indicating competition of sulfate or bisulfate ions with the anionic sulfate complexes of Ru(III), for the protonated amine groups. (auth)

27870 URANIUM FROM PHOSPHATES. Huber, H. Atomwirt., Atomtech., 13: 127-9(Mar. 1968). (In German).

The extraction of uranium as a by product from phosphate ores offers a possibility for improvement of the German uranium supply situation. The filtration of raw ammonium phosphate solutions, which serve for the large-scale production of ammonium phosphate fertilizers, produces sediments which, after drying, contain 0.15 to 0.8% of uranium dioxide and about 50% of phosphoric acid. The processing of these uranium phosphate ores to the commercial uranium concentrate and sodium phosphate results in a uranium production whose prime costs probably lie at under DM 50/kg of uranium contained in uranium concentrate and hence corresponds to the extraction from the highest grade uranium ores. In order to assess the economic prospects of this method for obtaining uranium the following questions are investigated in detail: 1. What do the uranium phosphate ores cost to manufacture and sell? 2. Will the possibly greater costs of manufacturing pure instead of raw ammonium phosphate be covered by a possibly increased return from the sale of the product? 3. Is the simultaneous processing of such ores to uranium concentrate and phosphate more efficient than the processing of the normal uranium ores? (auth)

27871 TREATMENT OF WATER IN THE EXPERIMENTAL REACTORS OF THE C.E.A. Dolle, L.; Conan, D. pp 161-85 of La Chimica dell'Acqua nei Reattori Nucleari. Rome, Comitato Nazionale Energia Nucleare, 1966. (In French).

From Symposium on Water Chemistry in Reactors, Rome. See CONF-213.

Experience gained in purification of water for CEA reactors is summarized. The processing is quantitatively very different for heavy-water reactors and for light-water reactors, but the principles differ only by secondary and economic considerations. The use of ion exchangers for elimination of ionic impurities is outlined with specific emphasis on the purification of heavy water for EL-2 and EL-3 reactors. Performances of the purification circuits are discussed. Colloidal Al_2O_3 is eliminated by centrifugation or filtration of the heavy water. Radiolysis processes occurring in the heavy water are described. The standards for chemical purity of heavy water are given. (J.S.R.)

27872 PROBLEMS RELATED TO THE CONTINUOUS PURIFICATION OF A LITHIUM OXIDE SOLUTION OF pH 10. Blain, C.; Platzer, R. pp 143-59 of La Chimica dell'Acqua nei Reattori Nucleari. Rome, Comitato Nazionale Energia Nucleare, 1966. (In French).

From Symposium on Water Chemistry in Reactors, Rome. See CONF-213.

The ion exchange purification of Li oxide was studied. The preparation of the lithium oxide solution and the purification circuit are described. The problems connected with the preparation of a cation exchanger in the Li form are considered in some detail. The development of a purification circuit operating under high pressure is described. (J.S.R.)

27873 EXTRACTION OF THORIUM AND CERBIUM(III) NITRATES WITH MIXTURES OF NEUTRAL SOLVENTS. Alian, A.; Haggag, A. (Atomic Energy Establishment, Insha, Egypt). Indian J. Chem., 5: 579-80(Nov. 1967).

The extraction of Th and Ce(III) with tributylphosphate, trioctylphosphine oxide, and tridodecylamine and their binary mixtures from aqueous aluminium nitrate medium is reported. Higher extraction is realized by using a mixture of the first two solvents. (auth)

27874 GAS CHROMATOGRAPHIC DETERMINATION OF ISOTOPIC MOLECULES BY MEANS OF OPEN TUBULAR THICK LAYER GRAPHITIZED CARBON BLACK COLUMNS. Goretti, G. C.; Liberti, A.; Nota, G. (Univ., Naples). J. Chromatogr., 34: 96-100(Mar. 26, 1968).

A new type of capillary column, the open tubular thick layer glass column, which combines the properties of the open tubular and of the packed columns by using as adsorption material graphitized carbon black, is reported. The column was effective for the separation of benzene, toluene, acetone, and pyridine from its deuterated counterpart. Chromatograms were run at various temperatures and in all cases an inverse isotopic effect was observed, the heavier species being always eluted first. These columns have a considerable amount of adsorbing material and the thickness of the layer may also be changed by using wires of different diameter in the column manufacture. They can be made to any length just as ordinary glass capillary glass columns and can operate with a low pressure drop. These features therefore permit separations that are not feasible with other columns. (P.C.H.)

27875 ISOTOPE SEPARATION FACTORS OF ^{14}C-AMINO ACIDS IN ION-EXCHANGE ON RESINS WITH CARBOXYLIC GROUPS. Bellobono, I. R. (Istituto Tecnico Industriale, Milan). J. Chromatogr., 34: 515-19(May 7, 1968).

The overall isotope effect in ion exchange for $^{12}C-^{14}C$ amino acids with isoionic points >7 was measured by an automated procedure. Isotope separation factors were then calculated by use of breakthrough curves at 25° and the height equivalent to a theoretical plate for the chromatographic column employed. They were found to be chiefly correlated with the pK_1 of the basic groups which are concerned in exchange interactions. (auth)

27876 SYNERGISM IN THE REVERSED-PHASE PARTITION CHROMATOGRAPHY OF AMERICIUM, CERIUM, AND LANTHANUM. Cvjeticanin, N. (Boris Kidric Inst. of Nuclear Sciences, Belgrade). J. Chromatogr., 34: 520-5(May 7, 1968).

Retention of the ions of $^{241}Am^{3+}$, Ce^{3+} and La^{3+} in reversed-phase chromatography was considerably higher on paper treated with a mixture of HTTA and TOP than if each extractant was used separately. The value for log $(1/R_F - 1)$ for all three ions reached a maximum at a fixed composition of components in the mixture. Thus a synergistic effect occurred not only in the liquid–liquid extraction process but also in the reversed-phase partition chromatography. The composition of the metallic species formed in the organic phase was determined by correlating log $(1/R_F - 1)$ with the amount of HTTA and TOP fixed on the paper and with the concentration of H^+ ions in the mobile phase at constant ionic strength. The results imply that species of composition $M(TTA)_3(TOP)_2$ are formed, which is in agreement with the data obtained by solvent extraction on the same system. (auth)

27877 SEPARATION OF CH_4 AND CD_4 USING POROUS POLYMER BEADS. Czubryt, J. J.; Gesser, H. D. (Univ. of Manitoba, Winnipeg, Can.). J. Gas Chromatogr., 6: 41-2(Jan. 1968).

A CH_4-CD_4 mixture was separated using a porous polymer bead column. The retention times were relatively short even at lower temperatures. The chromatographic peaks were symmetrical with negligible tailing. A 100-ft column was used, prepared by packing two 50-ft, $\frac{1}{8}$-in. OD copper tubes with porous polymer beads (Porapak Q, 50 to 80 mesh). [The two 50-ft columns were joined with a Swagelok union to give a 100-ft column. To minimize dead space each 50-ft column was terminated at both ends with a $\frac{1}{16}$-in.-thick plug of Foametal, and the Swagelok union was packed with the porous polymer.] Helium was used as the carrier gas. The chromatographic peaks were symmetrical and had relatively short retention times. Better separation could be obtained at lower temperatures and/or slower flow rates, but the retention times became much longer, such that a slight gain in separation nearly doubled the retention times. At 0°C there was a considerable degree of separation. The separation could be increased by a sample freezing technique. This was achieved by forming a small narrow U just past the injection port. The U was cooled to liquid nitrogen temperature, the sample then injected and allowed to freeze out in the U, after which the liquid nitrogen was quickly removed. This technique was most effective at higher column temperatures. The calculated number of the theoretical plates (with respect to CD_4) was 140 to 260 theoretical plates per ft for the various conditions. In a more recent experiment, separation of a CH_4-CD_4 mixture was achieved on a 50 ft $\frac{1}{8}$-in. OD Porapak S (50 to 80 mesh) column at –32°C in 20 min. (BBB)

27878 SEPARATION AND SECURING OF RADIONUCLIDES FROM LIQUID WASTE. v. Erichsen, L. (Univ., Bonn). Fortschr. Chem. Forsch., 9: 295-323(Oct. 1967). (In German).

The various techniques for decontamination are reviewed: dilution, concentration by distillation, precipitation (using hydroxide, Ca phosphate, Ca carbonate, complexes, silicate, Ca soap, destruction of precipitates, sediment separation), and ion exchange-adsorption techniques with inorganic and organic exchange materials. The handling of radioactive concentrates is discussed in terms of solidification; emphasis is placed on hydraulic binding, drying, calcination and sintering, inorganic fusion, and special binding materials; a comparison of techniques is made. Application of these techniques to different liquid wastes is illustrated. Final storage in tanks, burial vaults, certain geological formations, and mineral deposits, including salt and crystalline rocks is reviewed. (BBB)

27879 ARGON CELL USED TO REPROCESS REACTOR FUEL. Holcomb, William F. (Argonne National Lab., Idaho Falls, Idaho). Cryog. Eng. News, 3: No. 4, 21-5(Apr. 1968).

A shielded, high-purity, inert atmosphere cell for remote processing and refabrication of reactor fuels is described. The cell is circular, completely lined with continuously welded steel plate, and shielded with 5 ft of high-density concrete. Argon was chosen as the inert gas. Cell atmosphere control, first nitrogen filling of the cell, first argon filling of the cell, second argon filling of the cell, gas supply system, gas distribution system, and operation of the cell are discussed. (M.C.G.)

27880 DETERMINATION OF RADIOCESIUM IN FISSION PRODUCTS BY SORPTION ON AMMONIUM PHOSPHOMOLYBDATE. Krtil, J.; Bezdek, M.; Moravec, A. (Nuclear Research Inst., Prague). Collect. Czech. Chem. Commun., 33: 750-6 (Mar. 1968).

The sorption method was used for the determination of radiocesium in fission products with grained ammonium phosphomolybdate as the respective sorbent. The influence of the concentrations of nitric acid and ammonium nitrate, and of the amount of inactive cesium carrier was evaluated with respect to the sorption yields. Optimum conditions were ascertained for radioactive cesium capture, and sorption of some other fission products (Sr, Ce, Ru, Zr–Nb) was investigated under the same conditions. The sorption method used was verified by the isolation of radiochemically pure ^{137}Cs from an artificially prepared and natural mixtures of fission products in nitric acid. (auth)

27881 THIN-LAYER CHROMATOGRAPHY IN INORGANIC ANALYSIS. COMMUNICATION 2. SEPARATION AND DETERMINATION OF RARE EARTH AND OTHER IMPURITIES DURING THE ANALYSIS OF LANTHANIDE PREPARATIONS OF VARIOUS PURITY. Vagina, N. S.; Volynets, M. P. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Zh. Anal. Khim., 23: 521-8(Apr. 1968). (In Russian).

Thin-layer chromatography was used for the separation and determination of Fe, Cu, Hg, Zn, and Ca at concentrations of 10^{-2} to 10^{-1}% as impurities in rare earth preparations. Conditions were studied for the separation of accompanying elements (uranium and thorium) from rare earths in a thin layer of sorbent and for the separation of complex mixtures of rare earth elements (Nd–Pr). The separating of microgram amounts of lanthanides in different valence states Ce(III)–Ce(IV), Eu(II)–Eu(III) seems possible. (auth)

27882 EXTRACTION AND DETERMINATION OF URANIUM(VI) AS A COMPLEX WITH ARSENAZO III. Nemodruk, A. A.; Glukhova, L. P. Zh. Anal. Khim., 23: 552-7(Apr. 1968). (In Russian).

A study was made of the extraction of the complex of uranium(VI) with arsenazo III from strongly acid solutions with various organic solvents. Benzyl alcohol was found to be the best extracting agent, because its use permitted complete extraction of the reagent and its complex with uranium (VI) from an aqueous solution in a single extraction. The optimum concentration of acid (HNO_3 or HCl) in the initial aqueous phase was 5 to 6M, the concentration of arsenazo III was 3×10^{-4} to 4×10^{-4}M. Extraction of uranium(VI) as its complex with arsenazo III increased the sensitivity of determinations due to concentration of uranium during the extraction. The interference of many elements forming complexes which are not extractable was considerably decreased. (auth)

27883 IMPROVED ION-EXCHANGE PROCEDURE FOR THE PREPARATION OF HIGH-PURITY YTTRIUM. Persiani, C.; Cosgrove, J. F.; Walters, R.; Bracco, D. J. (Research Center of General Telephone and Electronics Labs., Inc., Bayside, N. Y.). Separ. Sci., 2: 789-96(Dec. 1967).

Yttrium oxide of 99.9999% purity was prepared by ion-exchange purification using electrically heated columns. Dowex 50W cation exchange resin in the hydrogen form was employed. Rare earth impurities were removed from commercial-grade yttrium oxide at both room temperature and 70°C. The separation efficiency was improved at higher temperatures. (M.C.G.)

27884 THE SEPARATION OF ZIRCONIUM AND HAFNIUM FROM DOMESTIC ZIRCON CAUSTIC FRIT. Cho, Chong-uong; Lee, Jai-phung (Atomic Energy Research Inst., Seoul). J. Nucl. Sci. (Seoul), 7: No. 1, 131-4(Oct, 1967). (In Korean).

The separation of zirconium and hafnium by an adsorption method using silica gel from caustic frit of domestic zircon sand was studied. The adsorption ratio of zirconium and hafnium by silica gel varied according to the concentration of hydrochloric acid in methanol solution. It reached adsorption equilibrium after about 1 hour of shaking. The distribution coefficients of zirconium and hafnium were determined for various concentrations of hydrochloric acid in methanol. The optimum concentration of hydrochloric acid in the solution was nearly 0.25 mole for the separation of zirconium and hafnium. (auth)

27885 COMPOUNDS FORMED DURING THE EXTRACTION OF URANYL NITRATE WITH TRIBUTYL PHOSPHATE. Nemodruk, A. A. Radiokhimiya, 9: 704-6(1967). (In Russian).

It was established that during the extraction of uranyl nitrate from saturated aqueous solutions with TBP the ratio of the sums of the mole fractions of TBP and water to the mole fraction of $UO_2(NO_3)_2$ in the extract does not depend on the extraction temperature and is equal to 2.0. A lower molecular weight of the extract than that for the disolvate $UO_2(NO_3)_2 \cdot 2TBP$ was connected with the fact that in the organic phase in addition to the disolvate a monohydrate-monosolvate was extracted. The content of this compound in the extract, saturated with uranyl nitrate, increased from 7.6 mole% in extractions at 0° to 66.1 mole% in extractions at 100°. (tr-auth)

27886 TREATMENT OF RADIOACTIVE EFFLUENT AND WASTES CONTAINING ISOTOPES OF SHORT AND MEDIUM HALF-LIVES FROM THE RADIOCHEMICAL LABORATORY, GRIESHEIM. Talsky, J.; Goette, H. (Farbwerke Hoechst AG, Frankfurt am Main). Chem.-Ing.-Tech., 40: 296-301(Mar. 1968). (In German).

The waste water is classified according to composition and origin and treated separately. Precipitation of the radionuclides with special combinations of flocking agents has proved a suitable method of purification. The solid wastes are divided into categories corresponding to their half-lives and reprocessed or disposed of separately. (auth)

27887 DECONTAMINATION OF RADIOACTIVE EFFLUENTS AT KERNFORSCHUNGSZENTRUM KARLSRUHE. Krause, Helmut; Nentwich, O. (Gesellschaft fuer Kernforschung mbH, Karlsruhe, Ger.). Chem.-Ing.-Tech., 40: 301-5(Mar. 1968). (In German).

The radioactive effluents (approx. 10,000 m^3 per year) are decontaminated by chemical precipitation, ion exchange, or evaporation in vapour-recompression evaporators, according to their content of radionuclides and non-active substances. The evaporation process was found to be the least dependent on the composition of the effluents, and chemical precipitation and ion exchange were found to be less effective. The highly radioactive concentrates that are obtained from the decontamination process are sealed in concrete or bitumen for disposal. (auth)

27888 EXTRACTION OF NIOBIUM AND TANTALUM FROM HYDROCHLORIC ACID SOLUTIONS BY TRI-N-BUTYLPHOSPHATE. Gibalo, I. M.; Albadri, Dzh. S. (Moscow Univ.). Vestn. Mosk. Univ., Ser. II. Khim., No. 3, 111-12(May-June 1967). (In Russian).

In the past, tributyl phosphate (TBP) was primarily used for the large-scale extraction of niobium and tantalum in the presence of sulfuric acid, both as a pure solvent or diluted with diluents such as kerosene and benzene; the extraction from hydrochloric acid solutions has not been studied. The mechanism of the extraction of these elements from solutions containing HCl was therefore examined to determine whether the process may be used to separate them from titanium and from each other. The 1 mg/ml solutions were prepared by melting the oxide mixture containing ^{95}Nb and ^{182}Ta as labeling isotopes, with potassium pyrosulfate and dissolving the melt in potassium tartrate solution. Investigation of the extraction mechanism from 10 N hydrochloric acid solutions indicated that both metals are extracted as the monosolvate. The chloride complexes of niobium were extracted by mixtures of TBP with other solvents, such as chloroform; a strong synergistic effect was noted. Other elements, e.g., Mg, Ca, Sr, Ba, Cr, Mn, Cu, Zn, Ag, and Cd are practically not extracted. The presence of hydrogen peroxide at low and elevated temperatures did not affect the extraction of niobium and tantalum by TBP and chloroform but if the solution is heated until the hydrogen peroxide is decomposed, the extraction of niobium is slightly reduced. The tantalum is extracted up to 7 to 10% while titanium remains completely in the aqueous phase. (TTT)

27889 INDUSTRIAL PROCESSING OF IRRADIATED U–Mo FUELS. Plessy, L.; Travert, J. Bull. Inform. Sci. Tech. (Paris), No. 123, 59-66(Feb. 1968). (In French).

Adaptation of the "Purex" scheme to U–Mo fuels causes serious problems only for the concentration of fission products solutions owing to molybdenum insolubility in acid medium. The industrial conditions for obtaining concentrates at 100 g/l are: addition of phosphoric acid sequestering the molybdenum at the beginning of concentration (0.33M in the end of cycle); holding acidity between 1.4 and 1.6N during concentration; and lowering of acidity to 1.0N at the end of cycle for storage. By way of compensation, fuel dissolution was more rapid than for nonalloyed uranium. (auth)

27890 RAPID RADIOCHEMICAL SEPARATIONS. Herrmann, Guenter (Univ., Mainz). Ark. Fys., 36: 111-26(1967).

From International Symposium on Why and How Should We Investigate Nuclides Far Off the Stability Line, Lysekil, Sweden. See CONF-660817.

Chemical separations within a few seconds are reviewed. Particular emphasis is put on methods that are promising for the on-line operation of isotope separators, i.e., on continuous separation methods via the gaseous state, as volatilization from solids at normal and high temperatures and recoil- or exchange-reactions with gaseous compounds. Some examples are also given for rapid discontinuous separations from solutions, e.g., volatilization, exchange with performed precipitates and liquid extraction with quasi-solid extracting agents. (90 references). (auth)

27891 ROZDZIELANIE IZOTOPOW NATURALNYCH. (Separation of Natural Isotopes). Selecki, Anatol. Warsaw, Panstwowe Wydawnictwo Naukowe, 1965. 538p.

A brief review is given on the isotopic separation theory and of applications of isotopes in research and technology. Isotopic effects in optical spectra and in chemical relaxation are analyzed. Isotopic analysis by densimetric, pycnometric, spectrometric, and magnetic resonance methods are reviewed. Cascade isotope separation, rectification, distillation, and chemical relaxation methods are discussed. Data are also given on isotopic separation by electrochemical, thermal diffusion, and diffusion methods. Selective isotopic separation is also discussed. (R.V.J.)

27892 SEPARATION OF CESIUM AND STRONTIUM BY ELECTRODIALYSIS. Webb, William H.; Hershey, Harry C.; Mitchell, Ronald D. (to United States Atomic Energy Commission). U. S. Patent 3,382,164. May 7, 1968.

A method for separating Cs values from Sr values in a conductive aqueous solution comprises adding a chelating compound capable of complexing one of these elements in an ion of opposite sign from that in which it was originally present and subjecting the solution to electrodialysis. (AEC)

27893 AQUEOUS AND SOLVENT EXTRACTION CHEMISTRY OF SOME OF THE ACTINIDE ELEMENTS, DETERMINATION OF THE INSTABILITY CONSTANTS AND CONDITIONAL EQUILIBRIUM CONSTANTS OF SOME COMPLEXES OF NEPTUNIUM AND PLUTONIUM. El-Ezaby, Mohamed Samir Abd El-Aziz. Salt Lake City, Univ. of Utah, 1967. 227p.

Thesis.

A purification scheme for ^{237}Np, contaminated with isotopes of Pu, using cation exchange chromatography was developed. ^{233}Pa, the immediate daughter of ^{237}Np, was eluted before Np(V) when 1 M HNO_3 was used. The Pu isotopes were eluted later with 3 M HNO_3. Bis(di-n-hexylphosphinyl) alkanes, dissolved in o-dichlorobenzene were used to extract Np(VI) (NpO_2^{2+}) and Pu(VI) (PuO_2^{2+}) from aqueous $HClO_4$. Bis(di-n-hexylphosphinyl)methane (HDPM) was also used to extract Np(VI) from aqueous solutions of HNO_3. It was found that as the ratio of HDPM concentration to that of Np(VI) or Pu(VI) increased the distribution ratio increased. From the partition data it was calculated that the extracted species were 1:1 Np-HDPM and Pu-HDPM complexes. Extraction of Np(VI) with HDPM from 1 M HNO_3 was also studied. A 1:1 complex of Np(VI)-HDPM was found. The conditional equilibrium constants of Np(VI)-HDPM and Pu(VI)-HDPM were calculated. The extraction of Np(VI) and Pu(VI) with these organophosphorus compounds was compared with that of U(VI) (UO_2^{2+}). Np(VI)-3-sulfosalicylic acid, Np(VI)-o-phthalic acid, Np(VI)-salicylic acid, Np(VI)-citric acid, Np(VI)-tartaric acid, Np(VI)-SCN, and Pu(VI)-salicylic acid systems were examined spectrophotometrically. The sulfosalicylate and phthalate systems were examined extensively. Both 1:1 and 1:2 complexes of Np(VI)-3-sulfosalicylate were determined. The instability constants of the complex formation reaction of both complexes were calculated. Also, 1:1 as well as 1:2 complexes of Np(VI)-phthalate were determined. The instability constants of their complex formation reactions were calculated. Addition of salicylic acid to a slightly acidic solution of Np(VI) caused the formation of a precipitate immediately. A preliminary study was done on the Pu(VI)-salicylic acid system. Both 1:1 and 1:2 complexes were determined. The instability constants of their complex formation reaction were calculated. Preliminary studies were done on Np(VI)-SCN, Np(VI)-tartaric acid, Np(VI)-trichloroacetic acid, and Np(VI)-citric acid systems. Preliminary fast reaction kinetic studies were done on Np(V) and Np(VI) in slightly acidic solutions as well as on the Np(VI)-salicylic acid system. Relaxation effects were observed. (Disser. Abstr.)

27894 EXTRACTION OF URANYL IONS USING MIXED SOLVENTS OF ACETYLACETONE AND PHOSPHORIC ACID ESTER. Bakos, L.

Thesis.

The acetylacetone (2,4-pentanedione)–phosphoric acid ester–uranyl ion extraction system and the equilibria occurring in it were studied. Spectrophotometric analysis of the metal content of the two phases performed with dibenzoylmethane provided the means for the determination of metal distribution. Measurements on the distribution were supplemented with determination of the pH value, spectrophotometric studies, and solubility tests. The measurements were carried out at 25°C ± 2°C. Distribution of the metal ion in case of extraction with mixed solvents is more extensive than that obtained by applying the solvents separately. The increment can be clearly demonstrated within the range of 5×10^{-4} to 5×10^{-2} M. The increase of distribution was measured in the presence of cyclohexane, benzene, and chloroform diluents. The increase of distribution diminished in the sequence of the diluents mentioned above. With solutions containing perchlorate, chloride, and nitrate ions of identical ionic strength the distribution is independent of the anion. In the presence of pyridine or pyridinium salts, distribution of the metal significantly increases even without phosphoric acid ester. According to ir spectrophotometric measurements the interaction between solvents can be excluded. By using Sillen's graphic method the formation constant of bis-(acetylacetonato)-dioxo-uranium(VI) ($\log \beta_{2,0} = 14.64 \pm 0.31$), its distribution constant ($\lambda_{2,0} = 0.68$), and the equilibrium constants of the associates formed with acetylacetone, tributyl phosphate, tricyclohexyl phosphate, triphenyl phosphate ($\log \beta_{2,1}$: 1.07; 3.27; 3.17; 0.29) were determined. The composition of the associates was confirmed by the results obtained by measuring the solubility. (Hung. Tech. Abstr.)

27895 IMPROVEMENTS IN OR RELATING TO THE PROCESSING OF METAL FLUORIDES. Grant, Albert Edgar (to United Kingdom Atomic Energy Authority). British Patent 1,107,388. Mar. 27, 1968. Filed Oct. 5, 1964.

A method is described for recovering a metal fluoride from a mixture of metal fluorides that contains UF_6 and at least one other metal fluoride soluble in liquid anhydrous HF. The mixture of fluorides is brought into contact with liquid anhydrous HF to dissolve at least some of the UF_6 and some other metal fluoride in the mixture. Any undissolved fluoride is separated from the HF solution, and the fluorides in the HF solution are recovered by distillation, crystallization, or precipitation as the oxyfluoride by the addition of H_2O to the HF solution. (B.L.M.)

EARTH SCIENCES

Geology and Hydrology

Refer also to abstracts 28189, 28193, 28194, 28262, 28304, and 30405.

27896 (IFA-IS-44) ABUNDANCE RESEARCH OF RADIOISOTOPES IN MINERAL WATERS OF CRISANA DISTRICT. Szabo, Arpad; Chereji, Iosif (Academia R.P.R., Bucharest. Institutul de Fizica Atomica). May 1967. 19p. Dep.

The results of measurements of the abundances of Rn, Ra, and U in 25 mineral waters of the Crisana District of Romania are presented. It was ascertained that there is no rational correlation between the natural abundances of these isotopes and the depth of the drillings. This is due to the fact that the drilling depths do not coincide with the depth from which the waters have their origin. There is a close connection between the radioisotope abundances and the geological–mineralogical structure of the rock strata. It has been found that in most cases the waters have their origin in calcareous rocks with radioactive elements in small amounts and for this reason the water radioactivities are insignificant. Only the waters that derive from triassic and jurassic calcareous stones and dolomites have more radioactivity. Every mineral spring whose radioactivity has been measured is in the allowable drinking range according to the safety standards. It is proposed that automatic devices be used for artificial increase of Rn content in the water in order to intensify the therapeutic effects. (auth)

27897 (NP–17358) MIKROSKOP, MIKROSONDE UND SCHAETZUNG DER URAN–BLEI-ALTER. (Microscopy, Microsonde, and Estimation of Uranium–Lead Ages). Ramdohr, Paul; Ottemann, Joachim; Schidlowski, Manfred (Max-Planck-Institut fuer Kernphysik, Heidelberg (West Germany)). 1965. 17p. (In German). Dep.

Polished sections of uraninite were studied under the reflected light microscope and then examined for U, Pb, Th, Ti, and Ce, by scanning with the ARL-microprobe. It is definitely possible to distinguish with these two methods between radiogenic lead which has remained at the place of its formation, and lead which has migrated. Therefore, a semiquantitative method of age determination for uranium minerals of different ages occurring in the same section is described. The uraninite grains in the gold bearing conglomerates from different deposits have different contents of minor elements and were of different ages when they were deposited in the conglomerate. (auth)

27898 DETERMINATION OF THE BORON CONTENT IN ROCKS BY NUCLEAR METHODS. Vakhtin, B. S.; Filippov, E. M. Geol. Geofiz., Akad. Nauk SSSR, Sib. Otd., 196-215(1966). (In Russian).

Methods of determining boron in outcrop, taking into account the effect of interfering elements are examined and a simple field set up for determining boron in powdered samples is described. This apparatus can determine boron quantitatively in outcrop when B_2O_5 content is between 0.5 and 6 or 8 percent. A scintillation neutron set-up can determine boron in powdered samples when B_2O_5 contents are between 0.1, 0.2 and 12.15 percent, with an accuracy of ±10 percent. In magnetite bearing rocks the effect of the iron can be taken into account by the scattered gamma ray method; moisture content can be taken into account by radioactive tracers. High concentrations of boron can be determined by the neutron alpha method, or by the neutron–neutron method using a pyrophyllite lining. The boron content in powders or outcrop can also be determined by a gamma spectrometer, recording γ–quanta with 479 keV energy. (Geophys. Abstr.)

27899 THORIUM, URANIUM, AND POTASSIUM ABUNDANCES IN PERIDOTITE INCLUSIONS AND THEIR HOST BASALTS. Green, D. H.; Morgan, J. W.; Heier, K. S. (Australian National Univ., Canberra). Earth Planet. Sci. Lett., 4: 155-66(Apr. 1968).

The abundances of the radioactive elements uranium, thorium and potassium in six lherzolite inclusions and their host basanites have been determined by neutron activation analysis and γ-ray spectrometry. The lherzolite inclusions have marked differences in K/U, K/Th and smaller differences in Th/U from the basanites. The contents of those elements in lherzolite inclusions are not determined simply by varying degrees of contamination by the host magma. The lherzolites are inferred to be accidental xenoliths in the host magma and their geochemical characteristics are representative of at least some parts of the upper mantle. They are considered to represent residual material left after extraction from mantle pyrolite of an undersaturated basaltic magma or after selective extraction of minor elements by wall-rock reaction processes. Processes of magma extraction from the mantle may lead to strong depletion of K in residual mantle peridotite with very little accompanying depletion in U and Th. The abundances of U, Th and K in the lherzolite inclusions are also compared with various estimates of upper mantle composition based on heat flow data. (auth)

27900 DISTRIBUTION OF β ACTIVITY IN THE BOTTOM MATERIAL FROM KOZLOV MOUNTAIN WATER BASIN. Kwapulinski, Jerzy (Warsaw Univ.). Nukleonika, 13: 239-49(1968). (In Polish).

The decay of specific β activity in the bottom matter from the Kozlov Mountain Water Basin reservoir was investigated. The specific activity of the sample increases moderately as it approaches the barrage. In spring and summer the specific activity of all samples was on an average larger. (auth)

27901 SOIL PROPERTIES INFLUENCING DIFFERENTIAL Ca TO Sr ADSORPTION. Khasawneh, F. E.; Juo, A. S. R.; Barber, S. A. (Purdue Univ., Lafayette, Ind.). Contract AT(11-1)-1495. Soil Sci. Soc. Amer., Proc., 32: 209-15(Mar.-Apr. 1968). (COO–1495-4).

The selectivity coefficient, the ratio of Sr to Ca as exchangeable cations divided by the ratio of Sr to Ca in solution, was found to vary from 0.61 to 1.51 on 63 Indiana soils. Soil factors influencing the variation in k_c values were studied on selected soils where k_c was determined after equilibration of the soil with an 0.1N chloride solution of Ca and Sr having a Ca/Sr molar ratio of approximately 190 : 1. Organic matter was negatively correlated with the k_c value ($r = 0.83$). Removal of the organic matter with H_2O_2 on nine soils increased the k_c value. The magnitude of the increase was correlated with the percent organic matter in the soil ($r = 0.89$). The organic fraction of the soil adsorbed Ca preferentially to Sr. The inorganic fraction in most instances adsorbed Sr preferentially. (auth)

27902 VOLUMETRIC DETERMINATION OF RADIOGENIC ARGON. Dubansky, Alois; Gottstein, Ottomar (Inst. of Geology, Prague). Chem. Listy, 62: 37-56(1968). (In Czech.).

The potassium-argon method is one of the most widespread geochronological methods for the determination of the absolute age of rocks. It is based on the radioactive decay of the potassium isotope ^{40}K, in which the argon isotope ^{40}Ar arises as one of the decay products. From the experimental viewpoint, this method depends on the quantitative determination of the K and the quantitative microdetermination of the Ar in the minerals and rocks. The present study is concerned with a new analytical method for the volumetric determination of radiogenic Ar. A new instrument technique and a new analytical method are described. The apparatus constructed makes it possible to use large samples (10 to 50 g) and permits the determination of Ar in the range of 0.05 to 50 mm^3 (normal conditions). For evaluation of the sensitivity and accuracy of the method, the question of the relative error in the determination of the radiogenic Ar and its reflection in the error in the determination of the absolute age of the sample were extensively discussed. The method was tested on a series of aluminum silicate minerals and rocks, especially on the plutonite of the Bohemian Massiv. The principal results are tabulated. These results represent important geochronological data of some localities of the middle Bohemian Pluton and Tepler Mountain. (tr-auth)

27903 MEASUREMENT OF NATURAL RADIOACTIVITY. I. DETERMINATION OF RADON IN UNDERGROUND WATER. Chung, Myung Cho; Yu, Kyong Hee; Chung, Hack Pil. J. Nucl. Sci. (Seoul), 7: 29-34(1967). (In Korean).

In order to determine the radon-222 content in underground water, 50 samples were collected in the Seoul area. The radioactivity was measured with a liquid scintillation counter after the extraction of radon by ethyl ether from water samples. In order to standardize the liquid scintillation counter for radon and its daughters, RaA and RaC were extracted from radon water by carbon tetrachloride in which dithizone was dissolved and subsequently RaB extracted by the same solvent. The radioactivity of RaB was measured by a windowless gas flow counter for beta counting. The following results were obtained: the counting efficiency of the liquid scintillation counter was determined as 203.8% compared with the RaB radioactivity measured by a gas flow counter; the radon concentration in 50 samples collected in the Seoul area was between $0 \sim 10.92 \times 10^{-9}$ Ci/l with higher concentrations in the samples collected from rock-based wells

than sand-based; extraction yields of radon from water samples by ethyl ether and of RaB by CCl_4(dithizone) were almost 100%; since this method of determination of radon is more simple than the conventional method, the chemical prospecting of radium and uranium ores may be done by this method; and it is valuable to review and discuss the radon activity in mineral or hot springs which contain high levels of radon and its clinical effects. (auth)

27904 RADIOELEMENT COMPOSITION OF SURFACE SOIL IN ADAMS COUNTY, COLORADO. Bunker, Carl M.; Bush, Charles A. U. S., Geol. Surv., Prof. Pap. 600-B, 71-5(1968).

Eighty-three samples collected from the Bennett, Manila, Horse Creek, and Sunnydale $7\frac{1}{2}$-minute quadrangle areas near Denver, Colo., were analyzed to determine the radioelement content and distribution. The radioelement concentrations are: 7.7 to 19.0 ppM thorium, 0.7 to 3.3 ppM radium-equivalent uranium, and 2.07 to 3.75 percent potassium. These data provide ground control for a proposed calibration of the U. S. Geological Survey's airborne gamma-radiation detection systems. (auth)

27905 URANIUM AND RADIUM IN THE ZONE OF ACTIVE WATER EXCHANGE OF THE NORTHEAST PART OF THE PRIPYAT BASIN. Gurskii, G. V.; Lukashev, V. K.; Tolkach, V. A. Dokl. Akad. Nauk BSSR, 11: 1017-20(Nov. 1967). (In Russian).

The results of the determination of the content of uranium and radium in different types of water of the active water-exchange zone were reported. Some regularities of the distribution of these elements, expressed in the increase of the content of uranium in the chloromagnesium waters and the decrease of radium in the water of a sulfate-sodium state, were established. The ratio of radium to uranium was determined and the displacement of the radioactive equilibrium toward some increase of the radium content was noted. The coefficients of water migration for the elements studied were calculated as 1 for uranium and 8 for radium. The character of the distribution of uranium and radium in water and surrounding rocks was examined. (tr-auth)

27906 ON THE FUNDAMENTAL REGULARITIES OF VARIATION IN THE PHYSICAL PROPERTIES OF ROCKS AND ORES FROM SOUTHERN BULGARIA. Dobrev, T. B. Izv. Vyssh. Ucheb. Zaved., Geol. Razved., No. 10, 112-16(1966). (In Russian).

Results of measurements of density, magnetic susceptibility, specific resistivity, and natural radioactivity of various rocks and ores from southern Bulgaria are compiled. (Geophys. Abstr.)

27907 CHOICE OF MEASUREMENT INTERVAL AND SMOOTHING OBSERVED CURVES IN AIRBORNE GAMMA SURVEY INVESTIGATIONS. Ostrovskii, E. Ya. Razved. Okhr. Nedr., No. 5, 45-7(1967). (In Russian).

To plot aerogamma survey maps it is necessary to smooth the raw data and, as a rule, to convert them to a discrete system of records; but with present manual methods of smoothing it is impossible to represent the continuous aerogeophysical curve as a system of discrete records. A solution to this problem is suggested which is based on investigation of the spectrum of the function $\Phi(t)$ recorded in the aircraft, followed by use of Koletnikov's theorem. The interval of discreteness O can be found for specific conditions of surveying after statistical choice of the boundary frequency from a number of experimental profiles. This interval can serve as the basis of the discrete representation of the aerogamma curves with uniform filtration of noise. (Geophys. Abstr.)

27908 DATING WORKS OF ART THROUGH THEIR NATURAL RADIOACTIVITY: IMPROVEMENTS AND APPLICATIONS. Keisch, Bernard (Carnegie-Mellon Univ., Pittsburgh). Science, 160: 413-15(Apr. 26, 1968).

The method for approximately dating white lead, which is based upon the decay of ^{210}Pb present in recently refined lead, has been modified to circumvent potential interferences. The modified method was applied to additional samples of known age and finds increased utility through special treatment of the obtained data. The method was also successfully applied to a number of interesting problems of authentication. (auth)

27909 NATURAL RADIOACTIVITY IN THE MATSUSHIRO EARTHQUAKE AREA. Hagiwara, Yukio (Tokyo Univ.). Tokyo Univ., Earthquake Res. Inst. Bull., 44: 1385-95(1966).

Natural gamma intensity patterns in Matsushiro Town and its adjacent area, Nagana Prefecture, reflect the principal variations in geology. Surface radiation ranges from about 3 to 12 microroentgens per hour. The high anomalies seem likely to occur around contact zones of different rock types, but no fault effect on gamma intensity can be manifested. There is at present no reason that an eruption will be induced by the earthquake swarm around Mt. Minakamiyama where no evidence for emanation of radioactive gases was found. (Geophys. Abstr.)

27910 USE OF NEUTRON GAMMA METHOD FOR DISTINGUISHING GAS BEARING RESERVOIRS IN THE YAKUTSK FIELDS. Bratash, V. P.; Zhokhova, R. M.; Zabelin, V. V. Neftegazov. Geol. Geofiz., No. 12, 19-22(1966). (In Russian).

Neutron-gamma logging immediately after drilling yields some interesting data on the gas-producing formations of Yakutia. When the invaded zones are deep it is necessary to conduct test operations to investigate the productive horizons by the neutron-gamma method, in which the level of the drilling fluid is lowered. The neutron-gamma logging procedure which uses the time intervals between the first and subsequent measurements did not give positive results for distinguishing gas-bearing from water-bearing formations with a large gas-oil ratio. (Geophys. Abstr.)

27911 ISOTOPIC DISTRIBUTIONS OF URANIUM AND THORIUM IN SOILS. Hansen, R. O.; Stout, Perry R. (Univ. of California, Davis). Soil Sci., 105: 44-50(Jan. 1968).

Data are presented on thorium and uranium concentrations in soil profiles and isotopic dis-equilibrations taking place as a result of soil formation. Soils were limited to those derived from granite materials in a temperate climate. Thorium and uranium concentrate as a result of rock weathering. Thorium and uranium losses occur but differential leaching favors uranium in one instance and thorium in another. Isotopic analysis by α-particle spectrometry is a useful means of studying mechanisms and rates of soil formation. (F.S.)

27912 DEHYDRATION AND DIFFUSION OF RADIOGENIC ARGON IN MICAS. Brandt, S. B.; Voronovskii, S. N. (Inst. of Geochemistry, Novosibirsk, USSR). Int. Geol. Rev., 9: 1504-7(Nov. 1967).

The stability of water in micas is determined by the kinetics of dehydration, and other mica properties and processes are associated with dehydration and dependent on it. The dehydration process is commensurate with changes in the dielectric loss angle, electroconductivity, and the amount of radiogenic Ar in the phlogopite sample. The dehydration activation energy and radiogenic Ar diffusion, in micas were determined and correlated with other data. Experimentally, dehydration and radiogenic Ar diffusion are a composite of 2 processes: that of low activation, proceeding rapidly at high experimental temperature (desorption); and that of uniform (volume) diffusion. The equality of the 2 forms of energy, and the measurability of K and D/a^2, suggested that atoms are displaced only after the OH displacement has left room in the mica crystal lattice. The chemically neutral radiogenic Ar atoms in mica's layered structure therefore constitute sensitive indicators of a dehydration process. Activation energy has been shown to be independent of grain size and pulverization technique. However, the degree of pulverization does affect the speed of the process (K and D/a^2), justifying the assumption that the boundary problem solution was determined to be correct for both diffusion and dehydration. This means that both diffusion and dehydration imply a series of elementary jumps, their number being determined by the geometry of mica. An explanation of these phenomena in the case of radiogenic Ar revealed that, when ^{40}K atoms disintegrate, the resulting ^{40}Ar atoms are driven into the mica structure by recoil, except those whose paths make a small angle with the cleavage plane. These remain in the unstable zone and may escape from the muscovite. This introduces an element of uncertainty in K/Ar absolute age figures from mica. (BBB)

27913 OXYGEN AND HYDROGEN ISOTOPE RATIOS IN SEDIMENTARY ROCKS AND MINERALS. Savin, Samuel Marvin. Pasadena, Calif., California Inst. of Tech., 1967. 228p. Thesis.

$^{18}O/^{16}O$ and D/H measurements were made on a variety of sedimentary rocks and minerals, with special emphasis on fine-grained, predominantly clay mineral fraction of sediments. The interlayer water was removed from clay minerals prior to the isotopic analyses. Precision of the measurements was generally ±0.2 per mil for oxygen and ±0.3% for hydrogen. In the case of zeolites the reproducibility was less constant because of difficulty encountered in removing zeolitic water. Listed in order of decreasing tendency to concentrate ^{18}O, the sedimentary minerals for which such data are available and their approximate isotopic fractionation factors relative to water at sedimentary temperatures are:

Mineral	$\alpha^{ox}_{mineral\text{-}H_2O}$	$\alpha^{hy}_{mineral\text{-}H_2O}$
Quartz	1.034	
Alkali feldspar	1.034	
Phillipsite	1.034	
Montmorillonite	1.0273	0.938
Kaolinite	1.0265	0.970
Glauconite	1.0263	0.926
Manganese nodule	1.015	0.923

Clay minerals, which form under sedimentary conditions, appear to form in isotopic equilibrium with their environments. Subsequent isotopic exchange may occur easily at elevated temperatures, but only extremely slowly at low temperatures. Ocean sediments that are detrital in origin have isotopic compositions reflecting the fresh water origin of their clay minerals. There is no evidence for any isotopic exchange of detrital clay minerals with the marine environment in any of the ocean cores studied. (The sediments could be as old as 250,000 years as determined by the ionium-thorium method.) Marine sediments that have large authigenic components are generally enriched in ^{18}O, reflecting the presence of phillipsite ($\delta\ ^{18}O = +34$ permil and montmorillonite $\delta\ ^{18}O = +29$ permil). However, those containing a high concentration of iron and manganese oxide may be isotopically light. (A manganese nodule had $\delta\ ^{18}O = +15$ permil.) The isotopic compositions of the clay minerals of ocean sediments are compatible with a weathering origin for a kaolinite and a metamorphic or diagenetic origin for chlorite. Monmorillonite and illite are primarily of weathering origin but both of these minerals may have diagenetic components. There is no evidence for any isotopic exchange of sandsized quartz or feldspar in the sedimentary environment, and these minerals may be used as indicators or provenance in sediments. The presence of a large authigenic feldspar or quartz component may be readily detected by oxygen isotopic analysis. An authigenic feldspar had an $^{18}O/^{16}O$ ratio 10 permil greater than igneous feldspars. Calculations were performed to determine the effect of weathering and the formation of sediments on the isotopic composition of the hydrosphere. It was concluded that those processes could have depleted the hydrosphere 3 permil in ^{18}O and enriched it 0.03‰ in D through the course of geologic time. (Disser. Abstr.)

27914 DIFFUSIONAL AND CONVECTIVE TRANSPORT OF MISCIBLE FLUIDS IN GRANULAR MEDIA. Bennett, Edwin Rupert. Berkeley, Calif., Univ. of California, 1967. 185p. Thesis.

The problem of disposal of radioactive gaseous wastes is approached on the basis of ground injection. The character of gaseous wastes from nuclear power reactors under different conditions is reviewed as well as the gas cleaning and disposal techniques in present use. Four concepts of ground injection disposal are discussed and evaluated in relation to geologic conditions of the reactor site and character of the waste discharge to be handled. The experimental studies deal specifically with mass transport of miscible fluids in homogeneous, isotropic, nonsorbing, granular media. A one-dimensional flow regime is used to investigate the interrelationship of longitudinal molecular diffusion and convective dispersion in the mass transport of gases through selected granular media and to relate those properties to the physical characteristics of the media. The results of the laboratory studies are used as a basis for describing the movement of injected waste gases through unsaturated earth media above the ground water table. (Disser. Abstr.)

27915 FACHTAGUNG UEBER DIE ANWENDUNG VON MARKIERUNGSSTOFFEN ZUR VERFOLGUNG UNTERIRDISCHER WAESSER IN GRAZ VOM 28. MAERZ BIS 1. APRIL 1966. (Specialists' Conference on the Tracing of Subterranean Waters in Graz, March 28–April 1, 1966). Maurin, Viktor; Zoetl, Josef. Steirische Beitraege zur Hydrogeologie, Jahrgang 1966/67. Graz, Leykam AG, 1967. 414p. (CONF-660343).

Thirty-two papers were presented at the conference on methods of tracing ground water flow using radioisotopes; use of radioisotopes in hydrography, hydrology, and hydraulics; equipment and methods for measuring ground water flow; methods for detecting radioisotopes in hydrological investigations; properties of radioisotopes for tracing ground waters; and the use of dyes and other nonradioactive methods for tracing ground water flow. (R.C.K.)

Meteorology

27916 (BNL–12401) RADIOACTIVITY AND FALLOUT: THE MODEL POLLUTION. Woodwell, George M. (Brookhaven National Lab., Upton, N. Y.). [1967]. 16p. (CONF-680424–1). Dep. CFSTI.

From Symposium on Challenge for Survival, New York.

Environmental contamination by radioactive materials and the scientific practices used to mitigate this contamination are examined to show how this knowledge can be used to help solve other pollution problems, especially environmental pollution from pesticides. (L.C.L.)

27917 (TID–24341) ^{90}Sr ON THE EARTH'S SURFACE. IV. SUMMARY AND INTERPRETATION OF A WORLD-WIDE SOIL SAMPLING PROGRAM: 1961–1967 RESULTS. Meyer, Milton W.; Allen, James S.; Alexander, Lyle T. (Soil Conservation Service, Beltsville, Md. Soil Survey Lab.); Hardy, Edward (New York Operations Office (AEC), N. Y. Health and Safety Lab.). May 1968. 22p. Dep. CFSTI.

A final world-wide sampling of soil for measuring the distribution and cumulative deposit of ^{90}Sr from nuclear testing, was conducted from 1961 to 1967. Deposition increments during this time period were very small, indicating that the maximum cumulative deposit probably occurred late in 1966. The latitudinal distribution of ^{90}Sr shows heaviest fallout between 30° and 60° north latitude, minima at the poles and equatorial region, and a peak in the southern hemisphere between 30° and 50° south latitude. The southern hemisphere peak is about $\frac{1}{5}$ the northern hemisphere peak. The total amount of ^{90}Sr on the earth's surface is 13 MCi, 82 percent of which is in the northern hemisphere. (auth)

27918 OBSERVED VALUES OF THE RADIOACTIVITIES IN ATMOSPHERIC FALLOUT. Taiki Hoshano Kansoku Seiseki, No. 46, 1-60(1967). (In Japanese).

The observed values of radioactivities in atmospheric fallout are tabulated covering various locations throughout Japan. The tabulated, observed values of radioactivities were obtained by methods such as measurements of temporary standard samples (U_3O_8), summary of mean radioactivities in rain, observed radioactivities in rain, observed radioactivities in airborne dusts by dust collectors, radioactivity measurements in sea-water (Apr. to Oct. 1966), and radioactivity measurements in rain-water and falling dust by gummed paper (May to June 1966). (NSA of Japan)

27919 COLLECTION AND DETERMINATION OF ^{131}I IN THE AIR. Baratta, E. J.; Chabot, G. E.; Donlen, R. J. (Public Health Service, Winchester, Mass.). Amer. Ind. Hyg. Ass. J., 29: 159-61(Mar.-Apr. 1968).

Data are presented on the collection and determination of ^{131}I from the air following the May, October, and December, 1966, atmospheric nuclear detonations by mainland China. The ^{131}I was collected on an alkaline barium–iodide–iodate impregnated filter and was determined by a destructive sulfuric acid distillation followed by collection and analysis of the gaseous ^{131}I evolved. Radioactivity measurements were made using a 3 × 3-inch NaI(Tl) 1-inch-well crystal coupled to a 200-channel γ analyzer. The variations in the amounts of ^{131}I recovered followed the gross β activities for these periods. It is not known definitely if the ^{131}I collected in this manner includes the organically bound ^{131}I. In future tests studies will be made to determine if all the forms of ^{131}I are collected by the barium-impregnated filter. (auth)

27920 URANIUM IN FALLOUT PARTICLES. Matsunami, T.; Mamuro, T. (Radiation Centre of Osaka Prefecture, Japan). Nature (London), 218: 555-6(May 11, 1968).

A study is described of the activity of uranium in highly active fallout particles roof collected shortly after several nuclear explosions. It is pointed out that such "hot particles" are very suitable for determining the abundance ratio of uranium isotopes in nuclear debris, since there is no contamination by natural uranium. Experimental techniques are described. Similar measurements were also made on rainwater and soil samples. Chemical separation of the uranium was made before alpha spectrometry. Results are tabulated for debris from the fifth Chinese explosion. The numbers of ^{239}Pu and ^{95}Zr atoms in each sample were also estimated. The presence of uranium in the Chinese debris was unexpectedly clearly detected, to the extent of 7×10^8 to 6×10^{10} atoms/μ^3. The uranium content in Soviet debris was below the detection limit (10^7 atoms/μ^3). It is considered that the uranium content in the Soviet particles was very low and may be explained as primarily the result of very strong fractionation; the particles were probably produced in thermonuclear explosions of very high yield carried out in the atmosphere, and became depleted in uranium content. $^{234}U/^{238}U$ ratios are discussed, and little evidence was found for enriched uranium. The main origin of the uranium is considered to be the tamper materials. The atom number densities of ^{95}Zr and ^{239}Pu are discussed. With regard to ^{95}Zr these densities are related to air or surface burst. The $^{239}Pu/^{238}U$ ratio appears to be related to neutron density in the fireball, and to the abundance ratio of slow to fast neutrons. (UK)

27921 METEOROLOGICAL ANALYSIS OF RADIOACTIVE FALLOUT CAUSED BY FOUR NUCLEAR EXPLOSIONS OF 1966 TO 1967. Murayama, N.; Fujimoto, H. Kishocho Kenkyu Jiho, 19: 575-98(Nov. 1967). (In Japanese).

Radioactive fallout from the nuclear explosions of the People's Republic of China on May 9, October 27, December 28, 1966 and June 17, 1967 was analyzed in Japan. Characteristics of the fallout are: the early arrival of radioactive fallout, including highly active particles, in the first three cases, particularly, in the case of the December 18, 1966 explosion, the second arrival of fallout due to the global circulation of the debris, in the case of December 28, 1966 (a high kiloton explosion), extremely large deposition of

radioactive fallout (consisting almost entirely of short-lived nuclides) which had never been experienced and, a strikingly small amount of radioactive fallout in the case of the June 17, 1967 explosion (the first hydrogen bomb of a low megaton class). Each of these characteristics is discussed with the aid of air trajectory charts of constant pressure levels (500, 300, 100 mb, and others) inclusive of circumpolar tracings. Good time agreement is obtained between the arrival of the debris and the air trajectories. As for the tropospheric fallout, it is found that an arrival of highly active (large) particles and the countrywide increase in fallout respectively can be predicted by the synoptic condition of the westerly jet stream and by tracing, with lateral diffusion considered, the 500 mb air trajectories which are considered to be representative of the tropospheric transport. An unexpectedly early appearance of the second fallout peak concerning the explosion on December 28, 1966 is examined by the cross-sectional analysis. Quick deposition of the debris from the tropopause level to the lower troposphere may be due to extremely strong downdraft fields in the middle latitudes. Meteorological analysis of the fallout caused by the nuclear explosion on June 17, 1967 suggests that a large portion of the debris had been injected into the stratosphere. (auth)

27922 FALLOUT RADIOACTIVITY NEAR MILAN AFTER THE 7TH CHINESE NUCLEAR EXPLOSION. Cerrai, E.; Triulzi, C. (CISE, Milan). Energ. Nucl. (Milan), 15: 204-9(Mar. 1968).

Fallout samples collected at CISE near Milan seven days after the 7th Chinese nuclear explosion (December 24, 1967) verified the presence of short-lived nuclides by means of gamma spectrometry. The determination of the content of ^{131}I, ^{140}Ba, ^{140}La, ^{141}Ce, ^{147}Nd, ^{91}Y, and ^{95}Zr was carried out through radiochemical separations. The radioactivity increase in fallout following this explosion appeared evident, as well as the increase after the 5th test (December 18, 1966). Measurements arranged for the 6th (June 17, 1967) on the contrary did not show any radioactivity increase. The trend of ^{137}Cs depositions from 1962 to 1967 is also reported; in the last year fallout was reduced so that the cumulative quantity in the ground tends to decrease. (auth)

27923 EVALUATION OF RADIOACTIVITY OF THE ATMOSPHERE IN CZECHOSLOVAKIA DURING 1966. Petrovic, Pavel. Meteorol. Zpr., 2: 157-64(Dec. 31, 1967). (In Czech).

Results of radioactivity determination in the atmosphere during 1966 are presented; the fallout values determined for the daily, weekly, and monthly periods are shown. Maxima of radioactivity determined during the year are discussed. Radioactivity of the atmosphere at Bratislava is described. Results obtained at 10 different locations in Czechoslovakia are presented in the form of tables. (JPRS)

27924 HIGHLY RADIOACTIVE FALLOUT PARTICLES FROM THE CHINESE NUCLEAR TEST EXPLOSIONS. Maruyama, Hideo (Nagaoka Technical Coll., Japan). Nagano Kogyo Koto Senmon Gakko Kiyo, 3: 167-73(July 1967). (In Japanese).

Highly radioactive fallout particles which were produced in three Chinese nuclear test explosions carried out in 1966 have been investigated. The nature of these particles was different from each other, because the burst conditions of the three explosions were different. The activity of the particles from the third Chinese nuclear explosion were proportional to the volume. The distribution density of the fallout particles due to the fourth Chinese nuclear test explosion was very small. The particles from the fifth explosion were much smaller in specific activity at a given age and considerably different in decay characteristics. (NSA of Japan).

27925 CONTINUOUS POINT SOURCE PLUME BEHAVIOR OUT TO 160 MILES. Peterson, Kendall R. (Air Resources Lab., Silver Spring, Md.). J. Appl. Meteorol., 7: 217-26(Apr. 1968).

In order to study the behavior of the plume emitted from the air-cooled nuclear reactor at Brookhaven National Laboratory on central Long Island radioactive argon-41 has been measured by an airborne gamma-ray spectrometer as far as 160 n miles downwind on a day with neutral stability. A vertical cross section at 144 n miles, obtained by a vertical "saw-tooth" sampling technique, shows the plume to be well organized with a nearly uniform vertical distribution to at least 2000 ft. The peak concentration when corrected for radioactive decay, decreases by about a factor of 7 to 10 over a distance of 150 n miles and a travel time of 10 to 12 hr. The lateral standard deviation of the plume appears to fit an extension of the Pasquill–Gifford "D" curve with distance, where σ_y (n miles) is approximately equal to two-thirds of the travel time in hours. (auth)

Mineralogy and Exploration

Refer also to abstracts 27899, 27947, and 28783.

27926 LOCALIZATION AND CONTROL OF URANIUM DEPOSITS IN THE SOUTHERN SAN JUAN BASIN MINERAL BELT, NEW MEXICO: AN HYPOTHESIS. Granger, Harry C. U. S., Geol. Surv., Prof. Pap. 600-B, 60-70(1968).

The Morrison Formation of Late Jurassic age contains primary uranium deposits along the southern margin of the San Juan basin in a belt at least 80 miles long and generally less than 10 miles wide. All known deposits seem to be directly beneath or closely downdip from areas where the structurally uptilted edges of the Morrison sandstones were exposed at the paleosurface by Early Cretaceous erosion. The primary deposits are coextensive with a carbonaceous residue that was presumably derived by solution from decaying vegetal matter, much of which was later incorporated into the Dakota Sandstone of Early and Late Cretaceous age. It is speculated that soluble carbonaceous material was carried downward into the exposed Morrison sandstones by meteoric water and precipitated at the water table. The mineral belt is therefore defined by the intersection of the paleo-ground-water table, which was periodically fluctuating, and the uptilted Morrison aquifers. Because of the probability that the carbonaceous material was not coprecipitated with the uranium but later accumulated uranium from ore-bearing solutions which permeated the rocks, the position of the carbonaceous residue constitutes a primary control of ore. (auth)

27927 FUTURE URANIUM DEMANDS. Davis, M. (United Kingdom Atomic Energy Authority, London). J. Brit. Nucl. Energy Soc., 7: 159-62(Apr. 1968).

An estimate is made of uranium demands to the year 2000 for projected nuclear power programmes, and this is compared with presently estimated uranium resources. Some consideration is given to the effect of price on demand. It is concluded that some work on low grade ores may be justified now, but work on resources exceeding \$10/lb U_3O_8 may be deferred until the current search for low price resources has continued for a few years. (auth)

27928 GEOLOGICAL SURVEY RESEARCH, 1966. CHAPTER C. Geol. Surv., Prof. Pap. 550-C, 1-267(1966).

Separate abstracts were prepared for two of the forty-three papers. The remaining forty-one papers covering various aspects of geology, geophysics, geochemistry, and mineralogy are not in scope of NSA. (R.C.K.)

For abstracts of individual papers see: 27929 and 27930.

27929 GENETIC IMPLICATIONS OF SOME ELEMENTS ASSOCIATED WITH URANIUM DEPOSITS, SHIRLEY BASIN, WYOMING. Harshman, E. N. U. S., Geol. Surv., Prof. Pap. 550-C, 167-73(1966).

A systematic distribution of uranium, selenium, ferrous and ferric iron, carbon, beryllium, and sulfate sulfur is shown by analytical data on samples of unaltered sandstone, ore, and altered sandstone from a roll-type uranium deposit in the lower Eocene Wind River Formation of the Shirley basin. Transportation of uranium and other elements in a neutral to slightly alkaline, oxidizing solution and deposition by changes in the Eh and pH of that solution are suggested by the geochemistry of these elements at low temperatures and pressures. (auth)

27930 FERROSELITE IN A ROLL-TYPE URANIUM DEPOSIT, POWDER RIVER BASIN, WYOMING. Granger, H. C. U. S., Geol. Surv., Prof. Pap. 550-C, 133-7(1966).

Delicate, stellate penetration twins of ferroselite occur in sandstone on the concave side of a roll-type uranium ore body in the Powder River basin, Wyoming. Comparison with occurrences in the Ambrosia Lake uranium district, New Mexico, suggests that the margins of altered rock may contain selenium concentrations irrespective of the presence of uranium. (auth)

27931 METAMICTIC RADIOACTIVE MINERALS AND THE METAMICTIC STATE. Orcel, J. Arch. Mineral., 26: 31-65 (1965). (In French).

Metamictization is the name given to processes leading to a state of disorder in the crystal lattice of a mineral sealing up radioactive elements. There are two major categories of minerals found in the metamictic state: first, a group of complex silicates including U or Th; second, all of the uraniferous niobotantalates and titanates. The process of metamictization is dominated by the action of α particles; β and γ radiation play practically no role. Return from the metamictic (structural disorder) state to the crystalline (ordered) state occurs generally in the course of an exothermic reaction. Studies of the process of metamictization are of great importance from the point of view of geology, geochemistry, and crystal chemistry. They produce data on the ages of rocks surrounding metamictic minerals, give information on changes produced in the earth's crust by disintegration of radioactive elements, and can assist in defining the nature of bonds between atoms in the crystal. (BBB)

27932 THE RADIOACTIVE BERYL PEGMATITE OF KOBOKOBO AND THE OTHER PEGMATITE AND VEIN MINERALIZATIONS OF THE REGION OF KAMITUGA, KIVU, REPUBLIC OF THE CONGO. Safiannikoff, A.; van Wambeke, L. (CCR-EURATOM, Ispra, Italy). Miner. Deposita, 2: 119-30(Sept. 1967). (In French).

The vertical repartition of the different phases of the Kobokobo Be pegmatite is inverted. Several petrographic units of equivalent importance are present. There is an exceptional concentration of beryl in the albite phase, an absence of tantalates, and a U-Th mineralization where secondary phosphates of Th are observed. The U is partially associated with phosphates of Al. Phosphates of Li, Ca, Fe, Mn, and Al are present, as are local mineralizations of colombite and cassiterite. The Li and Al phosphates may contain up to 6% U_3O_8, and minerals of the plumbogummite series associated with these include a new Th-U species still under study. A new U mineral also appears to be produced as a result of hydrothermal alteration. The zone corresponding to superficial alteration contains slightly raised activity (0.3 to 0.5%) due to U, and U is also dispersed in argile, limonite, and lithiophorite. The principal amount appears to be in evansite, as noted above, and also (0.5%) in coeruleolactite. (BBB)

27933 DEVELOPMENT OF URANIUM MINERALIZATION BY ZEOLITIZATION OF TRAHYLIPARITIC PORPHYRIES. Zlobin, V. A. (Inst. of Geology and Geophysics, Novosibirsk, USSR). Geol. Geofiz., No. 5, 44-54(May 1967). (In Russian).

The development of hydrothermal U mineralization by zeolitization of trahyliparite porphyries and zone formation about modified rocks is considered. Zones of zeolitization can lead to corresponding conditions of U mineralization and require careful investigation. U is concentrated at the periphery of the aureole of intense modifications, at the border of two zones (sericitization and albiticization) where alkalization of solutions occurs. Elements associated with U include Si, Ti, Al, Fe, Mn, Mg, Ca, Na, K, and P, and more particularly As, Cu, Pb, Zn, Sb, Ag, and V. U occurs in two forms: dispersed and in zones with redox potential lower than pitchblende. U mineralization is closely connected with hydrothermal metamorphic processes. (BBB)

27934 EXPLOITATION OF URANIUM MINERALIZATION BY ON-SITE DISSOLUTION. Beulaygue, M. (CEA, Paris). Ann. Mines, No. 2, 87-97(Feb. 1967). (In French).

Oxidized U dissolves easily in slightly acidic waters; thus in periods of high pluviometry exhaust waters from the l'Ecarpiere deposits have a titer of 40 mg/l U. The system used to take advantage of this observation, particularly with artificial wetting, is discussed; in practice the installation permits recovery of 30 tons U/year from waters with a titer of 100 mg/l with ion exchange resins. An analogous installation is foreseen for a neighboring deposit; others are in study. Certain bacteria with a high S-oxidizing activity have been discovered in the l'Ecarpiere deposit; these form H_2SO_4; studies are in progress to determine how these facilitate and increase the solution process. Conceivably similar processes may be employed for the recovery of surface mined material with content above 1 part per thousand, and for waste dumps. (BBB)

27935 THE PROPERTIES OF URANIUM IN PROGRESSIVE METAMORPHOSIS AND ULTRAMETAMORPHOSIS AS EXEMPLIFIED IN THE WESTERN ALDAN SHELF. Jermolajew, N. P.; Shidikowa, A. P. Z. Angew. Geol., 13: 123-5(Mar. 1967). (In German).

Geochemical studies of the characteristics of the precambrian, metamorphic, and ultrametamorphic U and Th bearing rocks of the Aldan shelf are compared with those of Saxony and of Norway. The concentration ratios of U and Th in various granitic rock formations are tabulated. The concentrations of these elements are in the range of 10^{-4}%. The ratio of Th to U ranges from 3 to 10. The amounts of U present decrease with increasing metamorphosis, as compared to the larger amounts found in paleozoic strata. This is confirmed by studies made on various metamorphic samples obtained from Norway, where the Th/U ratios are similar to those found in the Aldan shelf, but where the absolute values of these elements are lower in general. Progressive metamorphosis may be measurable by the amounts of U present. Recent findings suggest that sedimentary-metamorphic rocks may be potential sources of U ore, using methods that will free more than 40% of the U in the rocks. Metamorphic processes may not form U sources, but may cause release of U from the crystal lattice, structural and mechanical defects, and transition to new ore types. The evidence suggests that the radioactive elements migrated into the upper half of the lithosphere during the development of the earth's crust. The older metamorphic rocks contain 2 to 20 times less U and Th than formations from earlier geological epochs. (BBB)

27936 METHODS OF DETECTING AND ASSESSING LOW GRADE URANIUM DEPOSITS. Bowie, S. H. U. (Inst. of Geological Sciences, London); Bisby, H. J. Brit. Nucl. Energy Soc., 7: 169-77(Apr. 1968).

Instruments previously used for detecting and assessing uranium deposits are becoming obsolete and new equipment and methods are required, mainly to aid the discovery of deeply buried ore bodies which have no direct surface manifestations. Portable car-borne and air-borne scintillation ratemeters, and borehole logging equipment, are described and comments made on their use. Caution is advocated in the rigid classification of aeroradiometric anomalies obtained by gamma-spectrometer techniques. New techniques of measuring radon in ground air, and other search methods under development, are outlined. (auth)

27937 URANIUM RESERVES AND RESOURCES. Bowie, S. H. U. (Inst. of Geological Sciences, London). J. Brit. Nucl. Energy Soc., 7: 163-8(Apr. 1968).

Reserves and resources of uranium are defined, and estimates are given of resources and potential in the price categories of less than \$10, \$10 to 15 and \$15 to 30/lb of U_3O_8 in chemical concentrate form. Favorable areas in which new deposits of uranium are likely to be found are indicated, and the important factor of availability of known reserves is discussed. Information is also given on uranium that can be produced in relatively small quantities as a by-product in the processing of phosphate rock and monazite. Short-term requirements can be satisfied from presently known reserves; medium-term needs will become available only if immediate steps are taken to expand production and prove additional ore in existing fields; long-term sufficiency is likely to be assured if basic research on the mode of occurrence of uranium ore deposits is intensified and new methods of discovering hidden ore are evolved. As a safeguard against the non-discovery of additional major ore deposits, it is recommended that treatment research into the recovery of uranium from sub-marginal occurrences of conventional type, as well as from phosphate rock and shales, should be undertaken on an increased scale. (auth) (UK)

Oceanography

Refer also to abstract 28067.

27938 (HASL-196) ^{90}Sr AND ^{137}Cs MEASUREMENTS OF LARGE VOLUME SEA WATER SAMPLES. Sutton, Doris C.; Kelly, John J. (New York Operations Office (AEC), N. Y. Health and Safety Lab.). Apr. 1968. 44p. Dep. CFSTI.

Methods requiring less sample handling and fewer reagents than those of other investigators have been developed for the measurement of strontium-90 and cesium-137 in average 55 liter surface or deep sea samples. During four years, strontium and cesium yields averaged 75 ± 15 and 70 ± 10 percent, respectively. In the description of the methods, emphasis is placed on sample preparation; cesium isolation, from ammonium phosphomolybdate, its collecting reagent, attained by a single ion exchange pass in the presence of EDTA; sodium carbonate or ammonium carbonate as precipitants for strontium collection; reagent and sample quality control; beta counting and data analysis. Appended are derivations of equations used to calculate strontium-90 from yttrium-90 counting data and a program in Fortran IV for an IBM 360/30 computer which resolves the yttrium-90 data whether the sample is pure or contains short or long-lived contaminants. Data are listed for ten deep water samples collected in 1963 and 1964 from a depth range of 1500 to 4500 meters. (auth)

27939 SEDIMENTATION RATE DETERMINATIONS ON OCEAN BOTTOM CORES BY GAMMA RAY SPECTROMETRY. Pollard, Lin Davis. Tallahassee, Florida State Univ., 1967. 99p.

Thesis.

Gamma spectrometry in which the ^{230}Th daughter, ^{214}Bi, is nondestructively determined, is shown to be a reliable and simple method for sedimentation rate determination for the last 300,000 years. Gamma spectrometry overcomes some of the objections of standard radiochemical separation procedures, including whether or not the leaching procedures pick up allogenic as well as authigenic ^{230}Th. The count rates of ^{214}Bi, a gamma emitter of the ^{238}U radioactive decay series, are converted to the amount of uranium (apparent uranium), which would be in equilibrium with the ^{214}Bi activity by counting standards. When the apparent uranium is plotted against depth in the core, the curve approximates that of the growth of ^{226}Ra from its parent ^{230}Th and the subsequent decay. The curve displays a maximum at a depth greater than that at which the maximum would occur if the growth of ^{226}Ra were the only consideration. Thus the tops of the curves appear to have been altered by diffusion, primarily the diffusion of radium. The

apparent uranium values are compared with the thorium and uranium values determined by standard radiochemical procedures, which show that excess ^{230}Th, rather than real uranium, is reflected in the apparent uranium curve at the top of the core. The sedimentation rates calculated from apparent uranium data are compared with those calculated from $^{230}Th/^{232}Th$ ratios. A comparison is also made with the average sedimentation rates determined by paleomagnetic methods from the 700,000 years reversal. The comparisons of the independently determined sedimentation rates seem to indicate that the majority of the sediments used in this study were deposited at a slower rate for the last 300,000 years. (Diss. Abstr.)

Seismology

27940 DISCRIMINATION OF TEMPORALLY OVERLAPPING SEISMIC EVENTS. Anglin, F. M.; Manchee, E. B. (Dominion Observatory, Ottawa). Nature (London), 218: 757-8(May 25, 1968).

The mode of routine digital processing of seismic events recorded on analogue magnetic tape at the Yellowknife seismic array, Canada, is described. A recently processed event gave two sets of indications – (a) that it originated in the North Atlantic and (b) in NW China. Reasons for this are discussed, and it is stated that it is not unusual for the signal from one event to mask the arrival of a second event at any given station, nor is it unusual for the second event to be detected eventually, with the aid of data from other stations. Arrivals within 0.2 sec of each other are rare, but the method described makes it possible to detect the two events and determine their epicentres with some precision using only the data from one medium aperture array. (UK)

27941 STUDY OF AIR-BLAST-INDUCED GROUND MOTIONS. Auld, Harry Eugene. Urbana, Ill., Univ. of Illinois, 1967. 141p. Thesis.

The air-blast-induced ground motions resulting from large yield surface explosions are investigated with both theoretical and experimental studies. Fundamental one-dimensional wave propagation theory is presented with the primary emphasis on formulations which can incorporate the known stress-strain characteristics of soils. Loading waves in ideal elastic, plastic and shocking media are considered to bring out the important aspects of vertical wave propagation phenomena including the relationship between waveform parameters and the deduction of stress-strain curves from ground motion measurements. An existing solution for unloading waves in a material with a bilinear stress-strain curve is given and extended to give results for peak vertical stress and particle velocity attenuation resulting from a realistic nuclear airblast input. A general approximate method for treating one-dimensional wave propagation in a nonlinear, inelastic material is considered which can accommodate arbitrary pressure pulses, stress-strain characteristics and boundary conditions. This method is utilized for predicting ground motions for comparison with field test data. Results from multi-dimensional wave propagation studies are reviewed and then used to estimate horizontal ground motions and to assess the role of spatial dispersion in attenuation. A method for simulating air-blast-induced ground motions is discussed, which utilizes the detonation of high explosives in a confined configuration to attain durations comparable with those obtained in a nuclear environment. It is shown that the shock-front velocity and peak overpressure can be varied by respectively adjusting the two parameters associated with the design of the high explosive matrix. A comprehensive series of static one-dimensional compression tests were conducted on material which was obtained from a site where a large scale high explosive simulation test was performed. This information along with published results from other investigators is utilized to determine the stress-strain characteristics of soils from three sites for which ground motion data is available. Nuclear field test data, along with results from a high explosive simulation test and a conventional high explosive test, are presented for correlation with the theoretical wave propagation results. (Disser. Abstr.)

ENGINEERING

Nuclear Explosions

Refer also to abstracts 27920 and 29844.

27942 (PNE-3008) WATER RESOURCE APPLICATIONS, UNDERGROUND STORAGE OF NATURAL GAS, AND WASTE DISPOSAL USING UNDERGROUND NUCLEAR EXPLOSIONS. Cohen, Gerald D.; Sand, Francis M. (Mathematica, Princeton, N. J.). Aug. 31, 1967. Contract AT(04-3)-691. 82p. Dep. CFSTI.

Three separate papers dealing with peaceful uses of nuclear explosives are presented. The first reviews the need for augmenting natural water supplies by the end of this century, presents four ways in which nuclear explosives could aid in the recovery, storage, or treatment of water supplies, and recommends further experiments to verify the safety and feasibility of these applications. The second compares the cost of the nuclear process with conventional method costs. In terms of the combined cost of both creating the storage space and deliverability, the nuclear method shows great promise. Further research on the geologic settings and of locations for feasible application, as well as the safety consideration costs, is indicated. The third paper concluded that the use of nuclear explosives for creating underground storage for the disposal of sewage and industrial effluents is expensive and not currently warranted, but could prove to be a valuable addition to an anti-pollution program. (L.C.L.)

27943 (TID-24483) EMPIRICAL METHOD OF PREDICTING DAMAGE, NEVADA TEST SITE. Smith, Theodore L. (Holmes and Narver, Inc., Las Vegas, Nev. On-Continent Test Div.). Jan. 1968. Contract AT(29-2)-20. 27p. Dep. CFSTI.

A method of using experience to predict the vulnerability of structures and equipment to ground shock has been developed at the Nevada Test Site. Dimensionless factors called experience response multipliers (r_m) have been determined empirically for categories of structures and equipment for use in predictions. To avoid damage to structures and equipment a recommended minimum distance (R) is calculated using the empirical equation $R = r_m D$. A recommended minimum distance bears a relationship to the yield of the nuclear device. The use of the depth (D) of a proposed emplacement facility avoids security classification problems and provides a safety factor of unknown magnitude. Limitations to the use of this method are imposed by strict application of empirical disciplines. Although this method was developed for use as a field engineering tool, the experience response multiplier is being used to provide shock vulnerability information to the AEC for planning purposes. (auth)

27944 (UCRL-50409) OBSERVED FRACTIONATION IN GROUND LEVEL FALLOUT FROM THREE NUCLEAR CRATERING DETONATIONS. Gibson, Thomas A. Jr. (California Univ., Livermore. Lawrence Radiation Lab.). Apr. 4, 1968. 7p. Dep. CFSTI.

Data relating to radionuclide deposition (fallout) within a few miles of the Danny Boy, Sedan, and Palanquin nuclear cratering shots were examined for evidence of fractionation, i.e., differences in relative proportions of fission products in debris samples as compared with the relative proportions originally formed. A fractionation index is computed for several fission-product mass chains produced in each event. This index is particularly useful because it is independent of the total yield and fission yield of the detonation and also of the total amount of radioactive material deposited in the early fallout pattern. By comparing these indices with one another, one can determine whether fractionation occurred and obtain a quantitative estimate of its degree. For the three events studied here, only Danny Boy showed unambiguous evidence of fractionation in the early fallout, and the degree of fractionation was small. In Danny Boy there was only a factor of four difference between most enriched and most depleted species, as compared with the factors of several hundred that have been observed in many late time samples of airborne debris. If this small amount of fractionation proves to be true in general for cratering shots, then predictions of early-fallout gamma radiation patterns will be greatly simplified. (auth)

27945 (JPRS-44486) USE OF UNDERGROUND NUCLEAR EXPLOSIONS IN OIL-GAS MINING. Kedrovskii, O. L.; Mangushev, K. I. Translated from Geol. Nefti Gaza, 11: No. 12, 12-16(Dec. 1967). 10p. CFSTI.

The use of underground nuclear explosions to increase the recovery of oil and gas from deposits was investigated. The effects of such explosions on various underground media are examined and analyzed from data on US and Canadian explosions. (L.C.L.)

27946 EFFECTS ON RADAR OF PLASMA PRODUCED BY HIGH-ALTITUDE NUCLEAR DETONATION. Sittel, K. RCA Eng., 11: 41-5(Dec.-Jan. 1965-66).

A high-altitude nuclear detonation produces various forms of plasma which interfere with the propagation of radar waves in different ways. Such plasmas are therefore of serious significance to military system designers, since radar and/or communications system performance can be adversely affected by them. Characteristics of the different plasmas produced by nuclear detonations and some of their effects on radar systems are discussed. (Electron. Abstr. J.)

27947 SEEK PROFITABILITY ANSWER TO NUCLEAR IN-SITU COPPER LEACHING AT SAFFORD. Hansen, Spenst M.; Rabb, David D. World Mining, 4p(Jan. 1968). (UCRL-70780).

The proposed Sloop experiment to be undertaken jointly by the USAEC and Kennecott Copper for the nuclear in situ leaching of copper ore near Safford, Arizona is described. The topography of the ore deposit and the four phase planning for the experiment are discussed in some detail. (B.L.M.)

27948 AEROSPACE IN PERSPECTIVE: STRATEGIC WARFARE. Space/Aeronaut., 49: 96-107(Jan. 1968).

Recent developments in thermonuclear weapon delivery systems, particularly of the U.S. and U.S.S.R., are reviewed, as well as related topics, including seismic arrays for detection of nuclear detonations and antiballistic missile systems employing thermonuclear explosives. The most recently launched Vela satellites (for nuclear-test detection) have the capability of detecting booster exhausts using a high-resolution optical system. Nuclear test detection capability is improving. Three 320 lb Vela satellite pairs have been orbited; in April 1967, Vela 4, a 730 lb pair, was successfully deployed. Two different types of sensors are used; for vacuum bursts, an x-ray detector is needed; for atmospheric bursts, a uv or ir sensor (x-rays are converted to heat and light in the atmosphere). Vela 5 is slated for a late 1968 launch. All nuclear detection satellites are in a 50,000 to 60,000 nm circular orbit. For underground test detection, 525 seismometers coupled in the Montana Large Aperture Seismic Array (Lasa) are now in operation but still face ambiguity problems. Another Lasa, installed overseas, would help distinguish man-made seismic events from natural ones. The Spartan antimissile system makes use of a well-known nuclear phenomenon, the fact that 80% of the emission of a thermonuclear blast is in the form of γ rays. Although most of the γ-ray emission is converted into heat and light in an atmospheric explosion, exoatmospheric explosions provide a relatively free path for the rays to travel, and intensity at a given point follows the inverse-square law fairly closely. The heating effect of the radiation is a major kill mechanism in exoatmospheric explosions. Work is centered on concentrating the thermal output of nuclear explosions in the γ-ray region to maximize the radiation released in this range. The key advantage of this weapon is that it is a proximity device, capable of destroying warheads, decoys, and other penaids within an area of a few miles. (BBB)

27949 PLOWSHARE: PEACEFUL USES OF NUCLEAR EXPLOSIVES. Nucl. News, 11: No. 3, 23-44(Mar. 1968).

The development of technology for the peaceful use of nuclear explosives is described. The uses of nuclear explosives in large-scale earth moving projects such as digging sea-level canals, stripping rock layers from deep mineral deposits, cutting highways and railway passes through mountains, and the creation of harbors and lakes are described. The use of contained underground explosions to facilitate mining of ores and recovery of oil, to stimulate the flow of natural gas, or to produce underground reservoirs and permeable zones for storage or disposal of radioactive waste is discussed. The development of "clean" nuclear devices is also briefly discussed. (R.C.K.)

Facilities and Equipment

Refer also to abstracts 27732, 28037, 28615, 28911, 29297, 29383, 29385–29389, 29392, 29397, 29398, 29400, 29413, 29415, 29418–29420, 29423, 29425, 29435, 29456, 29459, 29581, 29807, and 30281.

27950 (AAEC/M-78) OPERATION MANUAL FOR 1000-TON HYDRAULIC EXTRUSION PRESS. Spain, S. W. A. (Aus-

tralian Atomic Energy Commission Research Establishment, Lucas Heights). Oct. 1967. 18p. Dep.

A description is given of a 1000-ton hydraulic extrusion press and its use for forging, cold pressing, or extrusion. A detailed list of operating instructions and a summary of service and maintenance requirements is included. (auth)

27951 (FOA-4-4347-24) LABORATORIEVALSVERK FOR KALLVALSNING AV PLUTONIUM. (Laboratory Equipment for Cold Rolling of Plutonium). Ekbom, Lars; Faxland, Svante (Forsvarets Forskningsanstalt, Stockholm (Sweden)). Mar. 1968. 13p. (In Swedish). Dep.

Equipment is described for cold laboratory rolling of plutonium. The total rolling force is 58.8 kNewtons. The lower limit of foil thickness is 0.05 mm and the largest foil width is 20 mm. The rolling speed can be varied from 0.01 to 0.10 m/sec. (Swed)

27952 (GEAP-5557) STRESS INTENSITY FACTOR FOR A CIRCUMFERENTIAL THROUGH-WALL CRACK IN A STRAIGHT PIPE. Gilman, J. D. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Jan. 1968. Contract AT-(04-3)-189. 51p. Dep. CFSTI.

The stress intensity factor for a circumferential crack in a cylindrical shell subjected to internal pressure and symmetric bending is calculated using energy methods. Application of the results to the failure analysis of piping in a nuclear power plant is discussed. Results are based on the calculation of strain energy as a function of crack length. The shell displacements are expressed in terms of Fourier series, and the strain energy due to shell bending and extension is represented as a function of the Fourier coefficients. The theorem of minimum potential energy is applied to obtain a set of linear equations, which are programmed for digital computer solution. The accuracy of the numerical results is discussed. (auth)

27953 (ORNL-4227) PRESTRESSED CONCRETE IN NUCLEAR PRESSURE VESSELS: A CRITICAL REVIEW OF CURRENT LITERATURE. Tan, Chen Pang (Franklin Inst. Research Labs., Philadelphia, Pa.). May 1968. Contract W-7405-eng-26; Subcontract No. 2721. 432p. Dep. CFSTI.

For Oak Ridge National Lab., Tenn.

The practices in design, analysis, construction, and inspection of prestressed concrete primary reactor pressure vessels are described and fundamental problem areas are discussed. The major components of the structures are identified and the features of these components unique to reactor vessel application are reviewed. Materials properties along with methods of specifying and selecting critical materials for service in the environments of interest are summarized. Criteria used in the design of vessels are compared and significant differences in the existing structures are identified. Modes of failure are summarized, and discussions of the use of models to predict behavior are included. Operational monitoring techniques for the determination of vessel performance with time are evaluated. (auth)

27954 (ORNL-TM-2050) A CONCEPTUAL DESIGN AND A COST ESTIMATE OF AN ON-SITE FACILITY FOR CLEANING, DISASSEMBLING, AND CANNING SHORT-COOLED LMFBR FUEL IN PREPARATION FOR SHIPMENT TO A CENTRAL REPROCESSING PLANT. Finney, B. C.; Lowrie, R. S.; Watson, C. D. (Oak Ridge National Lab., Tenn.). May 1968. Contract W-7405-eng-26. 30p. Dep. CFSTI.

A conceptual design and a preliminary cost estimate for a fuel preshipment preparation facility that would be located at a 1000-Mw(e) sodium-cooled fast-breeder-reactor station is presented. This facility would provide means for cleaning, disassembling, sorting (separating BeO rods from fuel rods), canning, and loading spent fuel rods (into casks) prior to shipment to a central reprocessing plant. The fuel would be allowed to cool for 10 to 25 days before the start of these operations. The facility would consist of a sodium removal area, a spent-fuel storage pool, a mechanical cell containing equipment for disassembling fuel elements, and a pool in which fuel cans could be stored and casks would be loaded. The design of the facility and associated equipment was only sufficiently detailed to allow a scoping type of cost estimate to be made. Based on present-day costs, the capital cost of the facility is estimated to be $5,050,000, and the annual operating cost (including amortization at 15%/year, operation, and waste disposal) is estimated to be $1,062,000. Assuming a reactor load factor of 80%, the unit cost of disassembling, sorting, and canning amounts to 0.152 mill/kWh; shipment of the fuel to a central reprocessing plant will cost an additional 0.029 mill/kWh. Thus the total unit cost of preprocessing operations would be 0.181 mill/kWh. From this preliminary study, it is apparent that the cost of such a facility would be prohibitive for a single reactor; however, if the cost could be distributed among six or more reactors, the facility could be justified economically. (auth)

27955 (ORNL-TM-2200) ESTIMATING THE RELIABILITY OF SYSTEMS. Fraas, A. P. (Oak Ridge National Lab., Tenn.). May 1968. Contract W-7405-eng-26. 32p. Dep. CFSTI.

Generic data on component reliability are reviewed, a simple method of applying these data is suggested, and some resulting implications with respect to the reliability of idealized systems are pointed out. Data for a number of familiar systems such as refrigerators, automobile engines, and TV sets are examined using the same technique and found to yield results consistent with those given by the simplified application of the generic data. The study concludes that there is an enormous amount of operating experience to indicate that the lowest failure rate one can reasonably hope to get in a piece of mechanical equipment such as a valve, pump, or motor is about one failure per million operating hours. From this it is shown that, if a system is to be designed for a 90% probability of operating 10,000 hr without a forced outage, it ought not require more than about ten thoroughly proven mechanical components (such as pumps) or one hundred thoroughly proven electronic components (such as resistors). (auth)

27956 (TID-4100(Suppl.44)) ENGINEERING MATERIALS LIST. Kelly, Robert C. (ed.) (Division of Technical Information Extension (AEC), Oak Ridge, Tenn.). May 1968. 53p. DTIE Free.

Twenty-eight packages of engineering materials on spectrometers and spectrometer equipment; standard instrument modules, rotating targets; cold traps; radiation heat facility equipment; pulse gamma facility; cryopumps; accelerator equipment; power supplies; pulsed arc welders; calorimeters; glove box facility; amplifiers; Sol-Gel and Salex process equipment; and detonators and igniters are announced for inclusion in TID-4100. (R.C.K.)

27957 (WAPD-TM-685) MICROSAMPLING TECHNIQUE FOR THE PREPARATION OF HIGHLY RADIOACTIVE MATERIALS FOR ANALYSIS IN UNSHIELDED MICROPROBES. Burton, R.; Campbell, C. E. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Apr. 1968. Contract AT-11-1-GEN-14. 25p. Dep. CFSTI.

A new microsampling technique has been developed to permit the remote sampling of minute specimens from any preselected region in highly radioactive metallic specimens with an accuracy unattainable by existing techniques. The design and operation of a newly developed, remotely operable punching tool is described. A detailed description of the operations involved in the preparation of metallic and ceramic types of irradiated materials is given. (auth)

27958 DYNAMIC SEAL TECHNOLOGY. III. TRENDS AND DEVELOPMENTS. Decker, Otto (Franklin Inst. Research Labs., Philadelphia, Pa.). Mech. Eng., 90: 44-8(May 1968).

A centrifugal seal was developed to run in liquid mercury for the Rankine-type turboalternator. The dynamic seals can be employed in industrial and commercial applications, offering long life, high reliability and efficiency with design simplicity. (auth)

27959 APPARATUS FOR LOW TEMPERATURE IRRADIATION. (to Commissariat a l'Energie Atomique). French Patent 1,435,968. Mar. 14, 1966. Filed Mar. 9, 1965.

The apparatus comprises a fluid-tight, thermally-insulated vessel for containing in its lower portion a bath of cryogenic liquid to be exposed to an intense radiation flux. For condensing vapors formed in the bath a fluid-cooled heat exchanger is used which is cooled by the working fluid of a cryogenerator. The working fluid is subjected to a Stirling cycle while the cryogenerator is located in a zone of low irradiation flux and at a level higher than the bath so that the condensed cryogenic liquid returns to the bath by gravity. (IIB)

27960 FUEL ELEMENT FABRICATION AND CONTROL LABORATORY. Com. Naz. Energ. Nucl., Notiz., 14: No. 2, 57-79(Feb. 1968). (In Italian).

The laboratory at Saluggia for the fabrication and control of fuel elements is described. The design and development of the various procedures are outlined. The installation consists of a section for the fabrication of metallic fuel elements, a section for the fabrication of ceramic fuel elements, and a quality control section. The activities and facilities of each section are discussed in detail. (J.S.R.)

27961 CREEP ANALYSIS OF AXISYMMETRIC BODIES USING FINITE ELEMENTS. Greenbaum, Gilbert A. (TRW Systems, Redondo Beach, Calif.); Rubinstein, Moshe F. Nucl. Eng. Design, 7: 379-97(1968).

An analysis and a numerical computer program were developed for calculating the creep strains in an arbitrary axisymmetric body of revolution subjected to axisymmetric loads. The method of solution is an extension of the direct stiffness method. The

body is replaced by a system of discrete triangular cross section ring elements interconnected along circumferential nodal circles. The equation of equilibrium for the body is derived from the principle of minimum potential energy. The creep behavior of the body is obtained by the use of an incremental approach. The method involves starting with the elastic solution of the problem and calculating the creep strains for a small time increment. These creep strains are treated as initial strains to determine the new stress distribution at the end of the time increment. The procedure is repeated until either the final time is reached or until the stress distribution is not changed, i.e., a steady-state condition is reached. The method is quite general and is independent of the type of creep law used. Results are presented for a plane-strain cylinder solution and a pressure vessel with spherical, elliptical, and flat end closures. (auth)

27962 THE EUREX PROGRAM. Com. Naz. Energ. Nucl., Notiz., 14: No. 2, 80-99(Feb. 1968). (In Italian).

The Eurex program at Saluggia is intended to furnish the technological and economic data for the design and construction of a plant for reprocessing irradiated fuel elements on an industrial scale. The Eurex plant was designed initially for the processing of M.T.R.-type fuels with high ^{235}U enrichment. The experience gained in the first three years of operation of the storage pool is reviewed. Short-term and long-term research and development programs are outlined. (J.S.R.)

27963 LARGE-FIELD TELECOBALT THERAPY WITH A MOVING TABLE: TECHNICAL ASPECTS. Mantel, Joseph; Scheer, Alan C. (Wayne State Univ., Detroit. Detroit Memorial Hospital). Radiology, 90: 799-800(Apr. 1968).

A moving-table technique for large-field telecobalt therapy is described. The table is used to move the patient under the open shutter of the ^{60}Co therapy unit for distances up to 60 cm. Application of the technique to the exposure of the paraaortic nodules, spinal canal, whole abdomen, and one hemithorax is discussed. (C.H.)

27964 METALLOGRAPHIC INVESTIGATIONS WITH THE EMISSION ELECTRON MICROSCOPE. Ringpfeil, Horst; Illgen, Lothar (Forschungsinstitut fuer Metallische Spezialwerkstoffe, Dresden). Prakt. Metallog., 3: 366-77(Dec. 1966). (In German).

Surfaces of solid specimens may be imaged in the emission electron microscope at temperatures up to 1200°C. The electron emission of the specimen required for forming an image is excited by ion bombardment. The construction and the operation of this apparatus are described and compared with the direct-light microscope. The preparation of the specimens is made by methods usual in metallography; embedding media however have to satisfy additional requirements. The special properties of resolving power, depth of focus, contrasts due to different materials or orientations, etching by ions are discussed by means of examples. At the same time these examples show the many-sided operational possibilities of the emission electron microscope in metallurgy. (auth)

27965 AN EXPERIMENTAL STUDY OF TURBULENT FLOW IN A SPIRAL-GROOVE CONFIGURATION. Burton, R. A. (Southwest Research Inst., San Antonio, Tex.). J. Lubric. Technol., 90: 443-9(Apr. 1968).

Pressure and velocity data are reported for measurements in a large-scale experimental apparatus, designed to act as a model of a spiral-groove configuration operating at turbulent Reynolds numbers, and using air as a working fluid. The results predict that inertial effects at the steps in film thickness will exert a dominant influence on flows in machine elements made in geometric similitude to the model. Negative gage pressures were indicated in the thin-film regions, and these would be expected to lead at times to film breakup in elements using a liquid as the working fluid. Furthermore, negative stiffness under displacement of the journal was indicated for some operating conditions. The results, taken together, indicate the role of inertial effects, and dangerous operating conditions as to film breakup and loss of load support. (auth)

27966 PERFORMANCE OF A MODIFIED PACKED-GLAND SEAL. Allen, C. M.; Rieder, W. G. (Battelle-Columbus Labs., Ohio). J. Lubric. Technol., 90: 417-23(Apr. 1968).

An experimental investigation of the mechanics of hydrodynamic lubrication and heat generation and dissipation of packed-gland rotary shaft seals was performed on a somewhat novel design. The design differs from conventional stuffing-box seals in that the packing was inverted so that it rotated with the shaft. It was also skewed so as to enhance heat transfer and lubrication. Further, the gland was loaded hydraulically so that the axial pressure applied to the packing was readily controllable. These modifications proved to be successful in that much improved stability of operation was obtained through lowered coefficients of friction (with water as the sealed fluid) and interface temperature which prolonged seal life without serious detriment to leakage. Some rheological data on Teflon-asbestos packing is presented as well as kinetic coefficients of friction. Motion picture frame photographic sequences of the packing interface showing packing deterioration and lubricant film cavitation are also included. (auth)

27967 SPIRAL GROOVE FACE SEAL CONCEPTS; COMPARISON TO CONVENTIONAL FACE CONTACT SEALS IN SEALING LIQUID SODIUM (400 TO 1000°F). Strom, T. N.; Ludwig, L. P.; Allen, G. P.; Johnson, R. L. (Lewis Research Center, Cleveland). J. Lubric. Technol., 90: 450-62(Apr. 1968).

Conventional face contact seal performance was improved by incorporation of the spiral-groove geometry. Both conventional face contact seals and seals with spiral grooves were used to seal liquid sodium at a pressure of 20 psig (14.0 N/cm^2 gage), and a sliding velocity of 79 fps (24 m/sec). In comparison with conventional face contact seals, seals with spiral grooves had negligible leakage. The wear and contact patterns indicated that the spiral-groove seal operated with separation of the sealing surfaces, which is necessary for long life. Supporting studies (sealing oil) on face contact seals employing the spiral-geometry are discussed. Successful low-leakage operation was not achieved with conventional face contact seals having carbide seal seats and nosepieces (hard on hard). Thermal and pressure distortions caused edge contact, wear, and scoring. Conventional face contact seals having seal seats and nosepieces with wear-in properties (soft on hard) showed more leakage than those with carbide sealing surfaces. (auth)

27968 BENDING OF CIRCULAR PLATES UNDER A UNIFORM LOAD ON A CONCENTRIC CIRCLE. PART II. Heap, J. C. (Argonne National Lab., Ill.). J. Eng. Ind., 90: 279-94 (May 1968).

The basic equations of deflection, slope, and moments for a thin, flat, circular plate subjected to a uniform load on a concentric circle were derived for four generalized cases. From these generalized cases, six simplified cases were deduced. The four generalized cases have the uniform load acting on a concentric circle of the plate between the inner and outer edges, with the following boundary conditions: (a) Outer edge supported and fixed, inner edge fixed; (b) outer edge simply supported, inner edge free; (c) outer edge simply supported, inner edge fixed; and (d) outer edge supported and fixed, inner edge free. (auth)

27969 BENDING OF CIRCULAR PLATES UNDER A VARIABLE SYMMETRICAL LOAD. PART I. Heap, J. C. (Argonne National Lab., Ill.). J. Eng. Ind., 90: 268-78(May 1968).

The basic equations of deflection, slope, and moment for a thin, flat, circular plate, under a symmetrical variable load, for a constant force divided by the square of the radial distance, have been developed. Six cases have been derived. The first four cases cover the variable load acting over the entire plate, viz., (a) fixed, supported, outer edge and fixed, inner edge, (b) simply supported, outer edge and free, inner edge, (c) simply supported, outer edge and fixed, inner edge, (d) fixed, supported, outer edge and free, inner edge; and the final two cases are for a solid plate having the acting variable load bounded by circles of an inner radius and the outer support-load-radius; i.e., (e) fixed, supported, outer edge and (f) simply supported, outer edge. (auth)

27970 AIR-CONTAMINATION CONTROL IN THE Pu FUEL DEVELOPMENT FACILITY. Kinoshita Mutsumi (Atomic Fuel Corp., Tokyo). Genshiryoku Kogyo, 13: No. 11, 46-50(Nov. 1967). (In Japanese).

The Pu fuel development facility was completed and has operated satisfactorily without major air-contaminations. The facility is equipped with glove boxes and is used for production of plutonium oxide and its mixture with uranium oxide, fabrication of fuel assemblies, and associated tests and experiments. Characteristic features of the Pu air-contamination, fundamental structure of the air-contamination control, glove boxes and ventilation system, safety handling of plutonium, occurrence of air contaminations, collective monitoring, survey by individual workers themselves, and air monitoring are discussed. (NSA of Japan)

27971 He GAS PURIFYING AND CIRCULATING DEVICE, DELIVERED TO JAERI. Ariyoshi, Shigeki (Ebara Mfg. Co., Ltd., Japan). Ebara Jiho, Special Issue, 73-4(Sept. 1967). (In Japanese).

A He gas purifying and circulating device for glove box treatment of plutonium is described. With this device, external impurity gases appearing in the operation of a glove box, including air, moisture and chemical fumes, can be almost completely removed. Moisture is adsorbed on silica-gel and molecular-sieve towers at ordinary temperatures, while impurity gases such as air are adsorbed on activated-charcoal traps cooled with liquid nitrogen. The circulating He gas can thus be maintained with less than

30 ppM of moisture, less than 10 ppM of oxygen, and less than 100 ppM of nitrogen. The device is capable of circulating He gas at 50 m^3/hr., and of continuous impurity removal for over a week at 10 l/hr. (NSA of Japan)

27972 STUDIES AT THE NUCLEAR CENTER OF YUGOSLAVIA. Hirling, Jozsef. Atomtech. Tajek., 10: 515-20(1967). (In Hungarian).

Yugoslavia was among the first countries to start systematic nuclear research and industrial development after World War II. The work is carried out in three institutes, located near Belgrade, in Zagreb and Lyublyana, employing more than 800 researchers. The Boris Kidric Institute near Belgrade was founded in 1947 and employs at present about 1200 persons. Its program covers basic sciences, such as nuclear physics, radiochemistry and radiation biology, and applied fields, including reactor technology, fuel element fabrication, nuclear electronics, isotope production and radiation protection. The work in physics covers the areas of nuclear, solid state and ion physics. The nuclear structure work centers primarily on the investigation of β and γ spectra; new lines have been discovered at the Institute in the spectra of osmium, platinum, dysprosium and other elements. New decay schemes have been proposed for several elements. Accelerator-generated deuterons were used for the study of light nuclei. A new laboratory was constructed in 1958 for radiochemical studies; a 3500-curie source is used for examining radiation-induced reactions. This work includes the development of chemical dosimeters. The Institute possesses a zero energy, heterogeneous, natural uranium, heavy water, bare reactor, suited for studying lattice parameters. A heavy-water, heterogeneous, Soviet-built reactor, operating with 2% enriched uranium fuel elements, with a nominal rating of 6.5 MW and a thermal-neutron flux of 3×10^3 n/sec. cm^2 represents an important research tool. In order to reduce costs, the auxiliary personnel was reduced, forcing the researchers to do many routine tasks. (TTT)

27973 PROBLEMS OF THE CURRENT STATUS AND FUTURE DEVELOPMENT OF RADIATION STERILIZATION BY THE MEMBER STATES OF THE EASTERN BLOC. Antoni, Ferenc. Atomtech. Tajek., 10: 521-5(1967). (In Hungarian).

A large portion of the material concerning radiation sterilization of drugs and foodstuffs consists of proprietary, therefore unpublished, information. The socialist countries are close to the capitalist ones in research in this field but are behind in the industrial-scale application. Radiation sterilization requires a close collaboration between the licensing and the operating agencies. In several countries including United Kingdom and Denmark, radiation sterilization represents a generally accepted activity but differences arise in the acceptable dose levels. The items for which this method of sterilization is used, include in addition to drugs, catgut, bandages, surgical sutures and instruments; good results were reported with the sterilization of plastic containers for packaging bacteriological specimens and vaccines. On a larger scale, the method was used successfully for sterilizing "white rooms" for space research. Following the lead of Turkey, the Danubian countries are considering the application of this method for bone banks. The subject is closely studied in Hungary where an 80-kCi ^{60}Co source is under construction for this purpose. It is proposed to organize specialized symposia for the experts from socialist countries, in order to promote international collaboration on this field. Adoption of the Code of Practice developed by the IAEA is also urged. (TTT)

27974 NUCLEAR FUEL RECOVERY TECHNOLOGY ADVANCES. Anderson, C. R. (General Electric Co., Santa Clara, Calif). Elec. World, 168: No. 20, 87-8(Nov. 13, 1967).

Developments in the nuclear fuel recovery industry are outlined including the predicted demands for such fuels to meet utility needs by 1980 and the general economics of producing reprocessed fuels. (L.C.L.)

27975 VARIOUS PROCESSES FOR DESALINATION OF SALINE WATER. Barluzzi, Francesco. pp 25-70 of Acqua e Energia Nucleare. La Desalinizzazione Delle Acque Marine. Barluzzi, Francesco. Rome, Comitato Nazionale Energia Nucleare, 1963. (In Italian).

Physico-chemical methods for desalination of water are described; these include fuels for distillation, distillation with solar energy, separation by freezing, demineralization by membrane penetration, and various chemical, physical, electrical, and biological procedures. The problems of corrosion and the formation of solid deposits during distillation are considered. (M.L.S.)

27976 GASEOUS DIFFUSION PLANTS FOR ENRICHED URANIUM PRODUCTION. Engineer, 225: 642-4(Apr. 19, 1968).

The U. S. gaseous diffusion plants at Oak Ridge, Paducah, and Portsmouth are briefly described, and the integration of their operation is illustrated. The costs of separative work are discussed. (UK)

27977 DYNAMICS OF A VAPOR CONDENSER. Ciechanowicz, W. (Inst. of Nuclear Research, Swierk, Poland). Nucl. Eng. Design, 7: 1-8(1968).

Three mathematical models for a vapor condenser are derived. The first model is two-pass on the tube side, and the parameters considered, such as water fraction, velocities and temperatures are treated as functions of space variables x and z and of time. In the other two models, which are one-dimensional, the equations are solved with respect to the x and z variables separately by the additional assumption that the parameters under consideration are mean values averaged over the z and x variable, respectively. (auth)

27978 UF_4 TO UF_6 CONVERSION FACILITY AND EQUIPMENT (Engineering Materials). (Goodyear Atomic Corp., Portsmouth, Ohio). (CAPE-1550).

673 drawings.

The 344 project described consists of the fluorination facility which is used to produce UF_6 from UF_4 (green salt). Architectural, mechanical, electrical, and piping drawings describe the facility including the building, ash storage facility, crane, monorail, tanks, exhaust stack tower, H.F. storage yard, cold traps, refrigeration and reactors. The building consists of a high bay 210 ft in length, 210 ft wide with a ground floor area of 62,678 sq ft, a second floor area of 13,015 sq ft, and a basement area or reactor pit area of 4,722 sq ft. The total volume of the building is ~2,509,000 cu ft. Four fluorination reactors are included, each of which is capable of producing 4 tons of U as UF_6 in a 24 hr day. Refrigerating equipment using Freon is provided for cooling cold traps and condensers. The ash storage facility provides inside storage for containers holding ash from the fluorination reactor. (For details see TID-4100 Suppl. 42.) (F.S.)

27979 REMOTE HANDLING ARM. Mettetal, Jean Claude; Gagliardi, Georges (to Siersatom). British Patent 1,111,039. Apr. 24, 1968. Priority date Oct. 6, 1965, France.

A remote handling arm is described for use on manipulators in laboratories handling highly radioactive materials. The arm consists of a first coupling member and a second coupling member complementary to each other, driving unit, driven member and driving member which are complementary so that they are engageable with driving and driven members of two other arms. A gear train is located between the driving unit and the driven member. The arm is used with manipulators adapted to lift and displace heavy loads. (F.S.)

27980 REMOTE-CONTROL MANIPULATOR. Ainsworth, Alan (to United Kingdom Atomic Energy Authority). British Patent 1,108,873. Apr. 3, 1968. Filed June 22, 1965.

The description of a master-slave manipulator consisting of electric transducer connected master and slave arms is presented. Master arms movements require electric response to transducers for fluid pressure operated motors for the slave arm. The electric response system consists of variable resistors to arm extensions. (D.C.C.)

27981 MANIPULATOR COUNTERWEIGHT SYSTEM. (to Central Research Labs., Inc.). British Patent 1,110,262. Apr. 18, 1968. Priority date Nov. 13, 1964, United States.

The description of a remote-control master-slave manipulator consisting of a horizontal support with a master arm pivotally connected to one end of the support and a slave arm pivotally connected to the other end is presented. The stationary portion of the master arm has a counterweight for balancing the arm in its movement around the pivotal connection with the support. An independent counterweight serves to balance the slave arm in its movement around the pivotal connection with the support. Counterweights serve the telescoping extension tubes of the master and slave arms also. (D.C.C.)

27982 HIGH TEMPERATURE FURNACE (Engineering Materials). (California Univ., Los Angeles). (CAPE-1720).

11 drawings

A simple, high temperature furnace is described which is used for nuclear magnetic resonance experiments in the range from room temperature to 1300°C. The atmosphere surrounding the sample may be controlled and a uniaxial stress may be applied to the sample. Temperature stability is obtained with a regulation circuit utilizing a thermocouple as a sensing element. Sufficient external cooling is provided by the laboratory environment. (For details see TID-4100 Suppl. 45) (F.S.)

27983 CRIMPING TOOL. Joannes, Jacques; Lupo, Henri (to Commissariat a l'Energie Atomique). British Patent 1,109,768. Apr. 18, 1968. Priority date Nov. 18, 1965, France.

The tool described crimps filiform elements, such as thermocouple wires, in longitudinal grooves machined inside fins of tubular elements. (P.G.C.)

27984 IMPROVEMENTS IN OR RELATING TO AUTOMATIC MILLING MACHINES. (to Commissariat a l'Energie Atomique). British Patent 1,109,718. Apr. 10, 1968. Priority date Aug. 19, 1965, France.

The machine, intended to mill fins on heat exchanger preforms to be used as sheaths for cooling U rods in a nuclear reactor, without intervention of an operator, comprises two milling cutter carriages, each provided with a plurality of parallel-milling disc shaped cutters parallel to the plane of the fins. The carriages are mounted on tables with rotatable supports in a plane parallel to the plane of the face to be machined. Jacks associated with pawl-and-ratchet wheels rotate the preform to present new faces for milling. Electrical contacts limit travel of the carriage in both longitudinal and transverse directions. (P.G.C.)

27985 MONOCHROMATIC X-RAY SOURCE. (to Parametrics Inc.). British Patent 1,108,399. Apr. 3, 1968. Priority date Dec. 7, 1964, United States.

The design of a monochromatic x-ray source is given in which the x-rays are produced by impinging alpha rays on a selected target. Applications for monochromatic x-rays include microradiography, composition analysis, and in various specific material and density gaging techniques. (J.C.W.)

27986 COMPACT MASTER-SLAVE MANIPULATOR. Haaker, Lester Walter; Jelatis, Demetrius George; Jennrich, Carleton Eugene (to Central Research Labs., Inc.). British Patent 1,105,851. Mar. 13, 1968. Filed Mar. 1, 1966.

The description of a master-slave remote-control manipulator adapted for full range operation with minimum head space requirements in the slave compartment is presented. The manipulator consists of a horizontal support, a master arm pivotally connected to one end of the support, and a slave arm pivotally connected to the other end of the support. A handle is located at the lower end of the master arm, and a grasp is located at the lower end of the slave arm. The slave arm includes a longitudinal stationary outer tube, a telescoping intermediate tube that is rotatable, and an inner tube that is also telescoping and rotatable. (D.C.C.)

27987 IMPROVED IRRADIATION CHAMBER. Schneeman, Justin Gerhardt British Patent 1,108,709. Apr. 3, 1968. Priority date Oct. 20, 1965, United States.

An irradiation chamber is described which consists of an irradiation source located in a shielded box that has a shutter-type door. The source is located above a horizontal conveyor belt which transports the specimens to be irradiated. The door is pivotally mounted on a horizontal axis and counterweighted to maintain a normal open position. A light and reflector are provided so that when the door is in open position the specimen is lighted. (D.C.C.)

27988 MATERIALS FOR USE IN CUTTING AND DRILLING TOOLS. Arthur, George (to National Research Development Corp.). British Patent 1,111,946. May 1, 1968. Filed Mar. 12, 1964.

A material for use in cutting and drilling tools is described having a matrix containing one or more carbides of transition metals and coated particles of hard boron compounds. The coating of the particles comprise a layer of titanium on the outside and the coated particles constitute 10 to 30% of the total volume. (J.C.W.)

27989 MASTER-SLAVE MANIPULATOR. (to Central Research Labs., Inc.). British Patent 1,110,261. Apr. 18, 1968. Priority date Nov. 13, 1964, United States.

The description of a remote-control master-slave manipulator consisting of a horizontal support designed for rotation on the longitudinal axis is presented. The manipulator includes a master arm pivotally connected to one end of the support and a slave arm pivotally connected to the other end of the support. Extensions on both the master and slave arms move relative to each other with the slave arm moving at a magnitude different from the master arm. (D.C.C.)

27990 SUPPORT SYSTEM FOR A LAMP FOR LIGHTING THE INSIDE OF A HERMETIC ENCLOSURE. Andre, Roger; Fradin, Jean; Renard, Michel (to Commissariat a l'Energie Atomique). British Patent 1,109,078. Apr. 10, 1968. Priority date Feb. 23, 1966, France.

The support system for a lamp for lighting the inside of a hermetic hot cell is described. The system consists of a hollow cylindrical body which has a head at one end and a passage through the biological screening wall. At the end of the passage is a yoke fastened to the head. The yoke secures the cylindrical lamp. The lamp can be positioned vertically or horizontally by movement of the yoke. (D.C.C.)

27991 IMPROVEMENTS TO SEALING DEVICES WITH EJECTABLE RINGS. Cazalis, Jean Pierre; Fradin, Jean; Vertut, Jean (to Commissariat a l'Energie Atomique). British Patent 1,112,055. May, 1, 1968. Priority date Apr. 7, 1966, France.

A sealing device with ejectable rings for chambers for manipulating radioactive objects is described. The device is composed of a semi-rigid support ring for fixing a detachable component such as a resilient sleeve, bellows, or glove inside an enclosing ring rigidly connected to the wall of the chamber with a locking ring. (W.H.K.)

27992 WATER BATH COLORIMETER NO. 94 (Engineering Materials). (Mound Lab., Miamisburg, Ohio). (CAPE-1675). 111 drawings.

An isothermal water bath calorimeter is described which is used in the nondestructive evaluation of radioisotopic heat sources. The measuring range is from 3 to 150 W. Percentage accuracy and precision errors are approximately constant on all power ranges. (For details see TID-4100 Suppl. 45.) (F.S.)

Heat Transfer and Fluid Flow

Refer also to abstracts 28008, 28774, 29599, 30186, 30217, 30282, and 30360.

27993 (GEAP-5417(Vol.1)) STEADY STATE AND TRANSIENT VOID FRACTION IN TWO-PHASE FLOW SYSTEMS. FINAL REPORT FOR THE PROGRAM OF TWO-PHASE FLOW INVESTIGATION. VOLUME I. Zuber, N.; Staub, F. W.; Bijwaard, G.; Kroeger, P. G. (General Electric Co., Schenectady, N. Y. Research and Development Center). Jan. 1967. Contract AT-(04-3)-189. 422p. (EURAEC-1949(Vol.1)). Dep. CFSTI.

Work Performed under United States-Euratom Joint Research and Development Program.

The results of an experimental and analytical investigation which was directed toward determining the effects of mass flux, heat flux, inlet subcooling, and system pressure on two-phase flow regimes, heat transfer coefficient pressure drop, and void fraction in steady state and in oscillatory operation are presented. Experimental apparatus and techniques are outlined for both steady state and oscillatory behavior. The experiments were performed with Refrigerant-22 in forced flow through a 0.40 in. ID, 60.5 in. long uniformly heated stainless steel test section. Simultaneous measurements were made of the void fraction, axial pressure distribution, wall temperature along the heated duct, heat flux, inlet velocity, and inlet and exit temperature of the fluid. Visual observations were made of the two-phase flow regimes in an internally heated glass test section which was geometrically identical to the stainless steel test section. Results obtained for both steady state and oscillatory operation are summarized. (R.C.K.)

27994 (GEAP-5417(Vol.2)) STEADY STATE AND TRANSIENT VOID FRACTION IN TWO PHASE FLOW SYSTEMS. FINAL REPORT FOR THE PROGRAM OF TWO-PHASE FLOW INVESTIGATION. VOLUME II. Zuber, N.; Staub, F. W.; Bijwaard, G.; Kroeger, P. G. (General Electric Co., Schenectady, N. Y. Research and Development Center). Jan. 1967. Contract AT-(04-3)-189. ^{285}P+ (EURAEC-1949(Vol.2)). Dep. CFSTI.

Work Performed under United States-Euratom Joint Research and Development Program.

Data tabulations are presented of the experimental and analytical investigations directed toward the determination of the effects of mass flux, heat flux, inlet subcooling, and system pressure on two-phase flow regimes, heat transfer coefficient pressure drop, and void fraction in steady state and in oscillatory operation. (R.C.K.)

27995 (SAAB-TN-63) SEMI-DISCRETIZED TREATMENT OF THE EQUATION OF CONDUCTION OF HEAT IN SOLIDS. ONE-DIMENSIONAL LINEAR FLOW OF HEAT. Bebrbobm, Hermann (Saab Aktiebolag, Linkoping (Sweden)). Sept. 1967. 77p. Dep.

The partial differential equation governing the one-dimensional conduction of heat in solids is semi-discretized by discretizing the space coordinate only, leaving time as a continuous variable. The complete and explicit solution is given for the system of ordinary differential equations into which the partial differential equation of conduction of heat is split by discretizing the slab of finite length into an arbitrary number of subintervals of equal length. Arbitrary temperatures, or fluxes of heat across the boundaries, or linear combinations of both, at the ends of the slab and variable with time, arbitrary initial temperatures along the slab, and arbitrary inner heat sources variable both in space and time, may be prescribed. The chosen system in toto, i.e., differential equation including the boundary conditions, is an approximation of the order $0((\Delta x)^2)$, where Δx is the width of the

space meshes. The eigenvalues of the first, the second, and the mixed boundary value problem can be explicitly given. The eigenvalues of the third boundary value problem depending of course, on the coefficients of surface heat transfer have, however, to be calculated numerically. Comparisons are made between analytic solutions of the semi-discretized system of approximating equations and analytic solutions of the exact equation of conduction of heat solids, showing the high approximating qualities of the semi-discretization method. (Sweden)

27996 (WAPD-TM-765) TRANSPORT OF PARTICLES IN TURBULENT FLOW TO CHANNEL OR PIPE WALLS. Beal, S. K. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Apr. 1968. Contract AT-11-1-GEN-14. 36p. Dep. CFSTI.

An analysis of the deposition of particles entrained in turbulent flow is presented. The method predicts the deposition of particles ranging from molecular size to about 100 microns in diameter; results agree reasonably well with published data. Stokes–Einstein turbulent diffusion, and inertial effects are accounted for. In addition, the existence of an equilibrium concentration of particles close to the wall is postulated. (auth)

27997 ACCELERATION OF THE CONVERGENCE OF SUCCESSIVE BLOCK OVERRELAXATION BY USE OF AN IMPROVED BLOCK PATTERN IN THE SOLUTION OF THE EQUATION FOR TRANSIENT HEAT CONDUCTION. Kaplan, B.; Wright, K. D. (Air Force Inst. of Tech., Wright-Patterson AFB, Ohio). Nucl. Sci. Eng., 31: 550-1(1968).

The employment of the implicit formulation of the finite-difference equations approximating the transient heat-conduction equation leads to problems of slow convergence, which are associated with the iterative solution of the simultaneous heat-balance equations. The results of numerical experiments that were conducted to study the effect of the order of scanning of mesh points on the acceleration of the convergence of the point successive overrelaxation (SPOR) method is discussed. The results showed that more rapid convergence is obtained from the use of a consistent ordering that rapidly utilizes the boundary net points to compute the interior net points. This effect is explicable in terms of the asymptotic convergence of the iterative process of SPOR. (auth)

27998 STUDY OF BUBBLE DEPARTURE IN FORCED-CONVECTION BOILING. Koumoutsos, N. (Democritus Nuclear Research Center, Athens); Moissis, R.; Spyridonos, A. J. Heat Transfer, 90: 223-30(May 1968).

Visual observations in a boiling liquid flow indicate that, as the flow velocity is increased, the size of bubbles leaving the heating surface decreases. The purpose of this investigation is to arrive at a criterion for bubble departure in forced-convection nucleate boiling. Photographic studies indicate that a little before departure a "neck" is formed joining the almost spherical bubble to the heating surface. From a consideration of the hydrodynamic stability of the bubble-and-neck model, the departure-size-to-velocity relationship may be predicted. Measured departure radii in a forced-convection boiling water system taken by means of high-speed photography are satisfactorily correlated with the results derived analytically. (auth)

27999 HEAT TRANSFER BY ORGANIC COOLANTS. Shlykov, Yu. P.; Leongardt, A. D. At. Energ. (USSR), 24: 46-8(Jan. 1968). (In Russian).

The turbulent heat exchange in tubes was investigated with consideration taken of the dependence of the thermophysical properties of the organic coolant on the temperature. The property variation, characteristic for these coolants with respect to flow cross section, showed effects on the heat transmission. The method proposed for the determination of the coefficient of turbulent heat transfer for non-isothermal liquid flow can be used for cases of the variation of all thermophysical parameters of the coolant. (tr-auth)

28000 EXPERIMENTAL ELASTIC STRESS ANALYSIS OF PARTIAL PENETRATION WELDED NOZZLES IN A SPHERICAL SHELL. Procter, E.; Flinders, R. F. (Central Electricity Generating Board, Berkeley, Eng.). Nucl. Eng. Design, 7: 73-86(1968).

The initial stage of a test program to investigate, in detail, the behavior of radial and oblique nozzle junctions in spherical shells, was completed. Although this stage was designed to investigate elastic and elastic/plastic behavior at ambient temperature, the elastic analysis only is presented. Three basic designs of through nozzles were investigated, one of each design mounted radially and the other at 45° obliquity. Four hundred strain gages were fixed on the inner and outer surfaces of the shell plate and nozzles and optical equipment was set up to measure tilt of the nozzles. For the purpose of this elastic test, the vessel was hydraulically pressurized to 240 psig. Stress distributions in the form of stress concentration factors (SCF = stress magnitude divided by the corresponding stress in an unpierced sphere of the same radius and thickness) are shown for the individual nozzles. Maximum values of SCF and "equivalent" stress are shown plotted against the ratio of nozzle thickness to nozzle internal diameter, for both radial and oblique cases. Comparisons are made with nozzles designed according to BS.1500 and BS.3915, and the limitations of elastic design methods allowing limited plasticity are demonstrated and discussed. (auth)

28001 DETERMINATION OF UNDISTURBED TEMPERATURES FROM THERMOCOUPLE MEASUREMENTS USING CORRECTION KERNELS. Beck, James V. (Michigan State Univ., East Lansing). Nucl. Eng. Design, 7: 9-12(1968).

A simplified method for determining the undisturbed temperatures from thermocouple measurements is presented. The determination of the temperature which would exist if the thermocouple were not present is facilitated through the use of some correction kernels which are used in a form of Duhamel's superposition integral. Kernels are given for the case of a thermocouple embedded normal to the surface of a low thermal conductivity material. (auth)

28002 COMBINED FREE AND FORCED CONVECTION IN A HORIZONTAL TUBE WITH UNIFORM INTERNAL HEAT GENERATION. Iqbal, M. (Univ. of British Columbia, Vancouver). Nucl. Eng. Design, 7: 49-58(1968).

Combined free and forced convection of a heat generating fluid in laminar flow inside a horizontal tube was investigated theoretically. The flow was considered fully developed and under uniform heat flux. Fluid properties were considered uniform except for the variation of density in the buoyancy terms. A perturbation solution to the governing equations was obtained and is valid for small values of the parameters representing heat generation and buoyancy terms. Expressions for velocity and temperature were developed. Nusselt numbers were evaluated. Within limits, with increasing values of heat source parameter, the axial velocity was not affected, however, temperature differences between wall and fluid become smaller and the Nusselt number was reduced. (auth)

28003 LIQUID METAL HEAT-TRANSFER EXPERIMENT AND ITS RELATION TO RECENT THEORY. Merriam, Richard L.; (Marquette Univ., Milwaukee); Stein, Ralph P.; Richardson, Bobbie L. Int. J. Heat Mass Transfer, 11: 769-72(Apr. 1968).

The more important results of an analytical and experimental investigation of liquid metal heat transfer in concurrent flow, double-pipe heat exchangers are summarized. (UK)

28004 A GENERAL UNSTEADY HEAT FLOW PROBLEM IN A FINITE COMPOSITE HOLLOW CIRCULAR CYLINDER UNDER BOUNDARY CONDITIONS OF THE SECOND KIND. Oelcer, N. Y. (Illinois Inst. of Tech., Chicago). Nucl. Eng. Design, 7: 97-112(1968).

A complete analytical study is presented for the distribution of three-dimensional unsteady temperatures in a hollow right circular cylinder of finite length and composed of two concentric radial layers in imperfect thermal contact. The prescribed rates of heat flow over the entire boundary, and the distributed heat sources in each layer are expressed in terms of arbitrary functions of space and time, the initial conditions being also arbitrarily prescribed. The general expressions, given in various forms, for the unsteady temperature field in the cylinder contain the solutions to many special problems of technological importance. (auth)

28005 SURFACE HEAT FLUX DETERMINATION USING AN INTEGRAL METHOD. Beck, James V. (Michigan State Univ., East Lansing). Nucl. Eng. Design, 7: 170-8(1968).

A family of methods is presented for calculating the surface heat flux from the transient temperature history measured at an interior position in a heat-conducting solid possessing constant thermal properties. These methods involve the numerical inversion of a convolution integral; i.e., the solution of a Volterra equation of the first kind. Each of the new methods employs a least-squares procedure. A comparison is given of the simplest formulation of the new methods with an older numerical inversion procedure employed previously. In this comparison it is shown that the new method is stable with time steps as small as one sixth of the minimum allowable time step in the previous method. Analyses of the stability are given for several formulations which have even more desirable characteristics. (auth)

28006 TEMPERATURE PROFILES IN LIQUID METALS AND THE EFFECT OF SUPERIMPOSED FREE CONVECTION IN TURBULENT FLOW. Buhr, H. O. (Univ. of Cape Town, S. Africa); Carr, A. D.; Balzhiser, R. E. Int. J. Heat Mass Transfer, 11: 641-54(Apr. 1968).

Temperature profiles measured in mercury and the NaK eutectic are reported for vertical flow in pipes under conditions of constant heat flux, and it is shown that the mercury profiles are distorted by a superimposed free convection effect up to Reynolds numbers of at least 50,000. A correlation is presented whereby the amount of distortion under given conditions may be estimated, and the shape of the undistorted temperature profile may be predicted. These profiles are used to determine the ratio of eddy diffusivities and the Nusselt number for liquid metals in the Reynolds number range 3×10^4 to 3×10^5. (auth)

28007 THEORY OF SIMILARITY OF HEAT TRANSFER. Stelzer, F. (Kernforschungsanlage, Juelich, Ger.). Kerntechnik, 10: 156-64(Mar. 1968). (In German).

The theory of similarity describes phenomena and processes in terms of model laws or characteristic numbers. It makes it possible to define and reproduce similar phenomena and processes. In heat transfer problems it is possible to avoid insoluble or cumbersome calculation problems. Starting from the notions of geometric and physical similarity, the model laws for fluid and heat flows are developed and the Reynolds, the Grashof, and the Prandtl numbers introduced. The Nusselt number, which is particularly important for convective heat transfer, is discussed and its practical application is shown in a numerical example. (auth)

Isotope Technology

Refer also to abstracts 27891, 27973, 27992, 28257, 28385, 28737, 28977, 29795, 29825, and 30365.

28008 (ALO-3634-8) RESEARCH AND DEVELOPMENT OF VACUUM FOIL-TYPE INSULATION FOR RADIOISOTOPE POWER SYSTEMS. Quarterly Progress Report, December 1967–February 1968. Carvalho, J.; Dunlay, J. B.; Fronduto, J.; Paquin, M. L.; Poirier, V. L. (Thermo Electron Engineering Corp., [Waltham], Mass.). Mar. 31, 1968. Contract AT(30-1)-3634. 66p. Dep. CFSTI.

Work on the development of high-temperature thermal insulation for radioisotope power systems is reported. Thirteen planar insulation samples were fabricated and eight of these tested in the planar heat loss test apparatus. The purpose of these tests is to evaluate the effectiveness of various spray coatings. Approximately 200 feet of tungsten foil was chemically etched from a thickness of 1.3 to 1.4 mils to a thickness of .3 to .4 mil. Six-inch wide tungsten foil cannot normally be purchased in thicknesses less than 1 mil. Slit-cup, overlap, and tapered corner assemblies were fabricated and tested in the edge heat loss test apparatus. The tapered corner was the most effective. The compatibility testing of aluminum, copper, nickel, and platinum foil in combination with alumina and zirconia is in progress. After 100 hours, zirconia appears to produce the least bonding between foil layers. (auth)

28009 (BNL-50099) FAILURE OF ^{60}Co RADIATION SOURCES. Wagner, J. I.; Milau, J. S. (Brookhaven National Lab., Upton, N. Y.). Feb. 1968. 39p. Dep. CFSTI.

About 217,000 curies of ^{60}Co Radiation Sources, BNL Mark I type, were shipped from Brookhaven National Laboratory to Honolulu, Hawaii, in February 1967 for use in the Hawaii Development Irradiator. When the shipping casks were opened in the irradiator pool, a black "cloud" was reported to rise out of the casks. Radioactivity was reported at the pool ion exchanger. The surface of the pool reached an activity of about 12 mr/hr. The probable causes of this activity release and means to avoid future similar occurrences are suggested. It is tentatively concluded that the major factor causing the extra-source activity was corrosion of the source cladding which penetrated to the cobalt core. The corrosion was probably due to the combined effect of low pH, dissolved metallic salts and lack of oxygen. Cobalt-60 was the only radioisotope detected. A replacement shipment of sources was made using modified shipment techniques developed during this investigation. Even though the cask was located on the weather deck of the ship and exposed to severe hurricane conditions, the receipt of the sources in as-shipped condition proved the efficacy of the modifications. (auth)

28010 (BNWL-681) PACIFIC NORTHWEST LABORATORY DIVISION OF ISOTOPE DEVELOPMENT PROGRAMS. Quarterly Report, July–September 1967. Moore, R. L. (ed.) (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jan. 1968. Contract AT(45-1)-1830. 22p. Dep. CFSTI.

Progress is reported on the development of promethium isotopic fuels and other radioisotope research programs. Fabrication of the 60 W Advanced Manned Strategic Aircraft (AMSA) heat source was successfully completed. Final impact testing of Phase II AMSA simulated heat source capsules was completed. Cold pressing and sintering of the Pm_2O_3 pellet for the AMSA capsule were carried out in a lead-shielded glovebox modified with an extension which fitted between the platens of a 200 ton press. Fabrication of the inner tantalum capsule and the outer L-605 alloy capsule was accomplished using electron beam welding. The dose rate of the encapsulated heat source was measured at 12 in. from its center. The AMSA capsule was measured for thermal output for a 48 hr period. The power output of the capsule was 60.32 ± 0.07 W at 95% confidence level. (R.C.K.)

28011 (CONF-660503) PROGRAMME OF THE 7TH CONFERENCE ON RADIOISOTOPES, NIPPON TOSHI CENTER, MAY 16–19, 1966. Abstracts of Papers. 397p. Dep.

The abstracts are grouped under the following topics: radiation synthesis, reforming of polymers by radiation, characteristic reactions in radiation chemistry, radiation measurement, instrumentation, physics, chemistry, radioisotope separation and refining, Moessbauer effect and adsorption, electronic computers in radioisotope utilization, use of gamma field for research on genetics and breeding, application of short-lived radioisotopes to agriculture and fishery, applications of radioisotopes to research on efficiency increase of fertilizer and insecticide, radioisotopic instruments in industry, safety of beta thickness gage, iridium radiography, fundamentals and applications of activation analysis, use of radioisotopes in research on life sciences, medicine and pharmacology, radioisotope handling facilities in hospitals, radiation dosimeters for medical use, radioisotopes in research on wear and lubrication, application of radioisotopes to public health, engineering, autoradiography, waste disposal, facilities, and problems on the practical use of food irradiation. (M.C.G.)

28012 (LA-DC-8185) THE LOS ALAMOS ISOTOPE SEPARATOR. Dropesky, Bruce J. (Los Alamos Scientific Lab., N. Mex.). [1965]. 4p. (CONF-660960-1). Dep. CFSTI.

From Symposium on Electromagnetic Isotope Separation, Oak Ridge, Tenn.

Operation of the Los Alamos Isotope Separator is reviewed. Adaptation of the Uhler retardation lens to various applications is discussed. Separation of ^{250}Cf from other californium isotopes was attempted but none was observed. A precision mass meter was added to the isotope separator. (M.C.G.)

28013 (MLM-1430) STABLE GASEOUS ISOTOPE SEPARATION AND PURIFICATION, JULY–SEPTEMBER 1967. (Mound Lab., Miamisburg, Ohio). Sept. 30, 1967. Contract AT(33-1)-Gen-53. 71p. Dep. CFSTI.

Topics covered include: carbon isotope separation, separation of isotopes of stable gases, thermal diffusion research, and low-temperature research. (M.C.G.)

28014 (MND-3322-7) SNAP 21A TEN-WATT DEEP SEA ISOTOPIC POWER SUPPLY. Quarterly Progress Report No. 1, March–May 1964. (Martin Marietta Corp., Baltimore, Md. Nuclear Div.). July 1964. Contract AT(30-1)-3322. 116p. Dep. CFSTI.

Initial development work on the SNAP-21A program is described. SNAP-21A is a 10-W undersea generator capable of operating under pressures to 10,000 psi with absolute containment of its ^{90}Sr heat source. The detailed preliminary design and analysis of a prototype electrically heated unit was completed. Thermoelectric aging tests were run to determine the most promising thermoelement bonding arrangements. The results have facilitated selection of the material combinations to be tested in a six-couple thermoelectric module test series. A thermoelectric couple test box was designed and a test procedure written which will allow the accumulation of the most useful data from this test series. Preliminary breadboard tests on the dc-to-dc power conditioner have shown an overall efficiency of 87.8%. This value will be increased to 90% by component matching. A method of conditioner regulation to maintain essentially constant hot junction temperature is under study. A safety program was also initiated. The materials selection from a safety standpoint was reviewed and design criteria are being defined. (L.C.L.)

28015 (MND-3322-13) SNAP 21A TEN-WATT DEEP SEA ISOTOPIC POWER SUPPLY. Quarterly Progress Report No. 2, June–August 1964. (Martin Marietta Corp., Baltimore, Md. Nuclear Div.). Oct. 1964. Contract AT(30-1)-3322. 116p. Dep. CFSTI.

The SNAP 21A system configuration was set. The titanium pressure vessel raw forgings are undergoing final machining. The uranium-8% molybdenum biological shield was received for use in the full-scale operating model. Tantalum-10% tungsten and Hastelloy-C rod was finish machined into the proposed fuel capsule configuration in preparation for seal welding and hydrostatic pressure testing. The thermoelectric couple for the SNAP 21A system, with a design thermoelectric efficiency of 10.4% at 950°F hot junction temperature is described. Initial fabrication of the selected ther-

moelectric couple showed that the temperature cycle required to bond the high performance cast lead telluride P element to the hot shoe caused a resistance increase of two to three times the initial element resistance. Subsequent lower temperature bonding cycles for assembly of the bismuth-telluride cold side segment and cold junction electrical conductor straps produced additional resistance increases in the P lead telluride element. Concurrent test data on hot junction pressure contact thermoelectric couples revealed lower initial power output than couples with metallurgical bonds at the hot junction. However, the pressure contacted couple performance remained essentially constant with time while P element performance reduction occurred in bonded couples. Based upon this performance data and the desire for high acceptance yield in manufactured couples, hot junction pressure contact was selected for the P side and hot junction metallurgical bond for the N side of the thermoelectric couple. SNAP 21A material galvanic corrosion studies were initiated. Power conditioner design and analysis were completed and a breadboard test was made showing that when operating at a generator input to the converter of 1.8 volts, rated output of 10 watts was maintained at 24 volts dc with an overall system efficiency of 94%. The safety analysis of the SNAP 21A generator showed that by proper design of a generator shipping pallet, air transportability was entirely feasible. (J.C.W.)

28016 (MND-3322-19) SNAP 21A TEN-WATT DEEP SEA ISOTOPIC POWER SUPPLY. Quarterly Progress Report No. 3, September-November 1964. (Martin Marietta Corp., Baltimore, Md. Nuclear Div.). Jan. 1965. Contract AT(30-1)-3322. 104p. Dep. CFSTI.

Component performance testing of segmented thermoelectric couples and modules, hydrostatic tests of the titanium pressure vessel and quick-disconnect electrical feedthrough, and weld development for the tantung fuel encapsulation material were undertaken. Detail draft specifications for the prototype generator system, power converter/regulator, and fuel capsule were also prepared. Test specifications for performance tests of thermoelectric couples, modules, and the full-scale system operating model, and the insulation assembly, were prepared. All major material procurement items were received with the exception of the insulation assemblies. (J.C.W.)

28017 (ORNL-4247) REACTOR PRODUCTION AND CHARACTERIZATION OF ^{109}Cd. Lewis, R. E.; Butler, T. A. (Oak Ridge National Lab., Tenn.). May 1968. Contract W-7405-eng-26. 13p. Dep. CFSTI.

Two methods for production of ^{109}Cd were examined: neutron irradiation of ^{108}Cd and natural silver. Effective neutron capture cross sections were determined to be 1.1 and 700 barns for ^{108}Cd and ^{109}Cd nuclides, respectively. The specific activity and the purity of the ^{109}Cd products obtained by both methods of preparation are compared. The achievable specific activity of ^{109}Cd is greater when enriched ^{108}Cd is used as target material; however, traces of ^{115m}Cd produced from ^{114}Cd in the target material limit the usefulness of the product. Cadmium-109 prepared from silver is free of other radionuclides of cadmium. The rate of production of ^{109}Cd from enriched ^{108}Cd and from natural silver and the chemical recovery and purification processes for each method of production are described. (auth)

28018 (PAEC/Chem/Misc-1) LABELLING SAND WITH RADIOISOTOPES. Progress Report, March 1963. Lodhi, M. A.; Ali, Shaukat (Atomic Energy Centre, Lahore (Pakistan)). Feb. 1967. 8p. Dep.

Radioactive tracers have proved very useful in the study of sand transport in hydraulic channels. Two methods have been described for labeling the sand with radionuclides. One of the methods is to deposit a thin layer of metallic radionuclides like ^{198}Au and ^{110}Ag on the surface of the sand by using formaldehyde as a reducing agent. The method is comparatively quick. The other method which is of a wider utility consists of giving a surface coating of the desired radionuclide by mixing it with albumen solution. The methods described require no pretreatment of sand except simple washing. (auth)

28019 SWEDEN'S FIRST ISOTOPIC-POWERED LIGHTHOUSE. Hjertberg, Carl G. Tek. Tidskr., 98: 309-10(1968). (In Swedish).

A lighthouse is briefly described. It is the first one powered with a radioactive isotope and is installed in Sweden. The power source consists of 10 Ci strontium-90 (as $SrTiO_3$). It produces 1W of power at 12V. The lighthouse is placed on Tegelhaellan at Stavsnaes in the Stockholm archipelago. (Swed)

28020 USE OF γ-EMITTERS IN THE INVESTIGATION OF SEDIMENTATION IN FLOCCULATION PROCESSES. Niederstrasser, H.; Smiricz, G.; Sontheimer, H. (Univ., Karlsruhe, Ger.). Chem.-Ing.-Tech., 40: 338-8(Apr. 10, 1968). (In German).

In order to investigate the sedimentation behavior of flocs, a γ-emitting radionuclide that is co-precipitated on floc formation is added to the water. The sedimentation process may then be followed by means of the variation with time of the counting rate registered by a scintillation counter on the bottom of the vessel. The main advantage of the method is that the rate of sedimentation may be measured directly for the whole range of flocculent concentrations encountered in practice, i.e., without having to concentrate the sediment as is otherwise often necessary. (auth)

28021 DETERMINATION OF THE THERMODIFFUSION CONSTANT IN THE MIXTURE OF ZIRCONIUM TETRACHLORIDE AND HAFNIUM TETRACHLORIDE VAPOURS. Spitsyn, Vikt. I.; Komissarova, L. N.; Tsirel'nikov, V. I. (Moscow State Univ.). Dokl. Akad. Nauk SSSR, 176: 374-7(Sept. 11, 1967). (In Russian).

In addition to separating isotopes the method of thermal diffusion can also be used to separate element pairs which are close in properties such as Zr and Hf. The thermal diffusion constant α is determined from the following relation: $\alpha = \log q/(\log T_1/T_2)$. Here q is the separation factor, and T_1 and T_2 are the lower and upper temperatures, respectively. Mixtures of $ZrCl_4$ and $HfCl_4$, containing 10, 25, 50, and 75% $HfCl_4$ and tagged with radioactive ^{181}Hf, were placed in a quartz ampule consisting of two sections 80 mm high and 20 mm in diameter joined by a tube 6 mm in diameter and 90 mm long. The temperature of the upper reservoir was controlled at 600 to 1000°C, while the temperature of the lower reservoir was held constant at 350°C to avoid convection effects. The difference in radiation readings between the two reservoirs was a measure of the separation factor. The average value of α at 10 to 75% $HfCl_4$ concentration was found to be 0.047 ± 0.006. Thus thermal diffusion can be successfully used to separate mixtures of $ZrCl_4$ and $HfCl_4$. (TTT)

28022 SEPARATION OF ISOTOPIC MIXTURES OF POLYATOMIC GASES BY THERMAL-DIFFUSION COLUMNS: INTERPRETATION OF DATA ON OXYGEN. Raman, S.; Saxena, S. C.; Watson, W. W. (Yale Univ., New Haven). J. Chem. Phys., 48: 2920-23(Apr. 1, 1968).

The extension of Furry and Jones theory of thermal-diffusion columns (or more appropriately its generalized version given by Saxena and Raman) to pure polyatomic gases by Youssef and Hanna is used to interpret the experimental results of Narten and Landau on oxygen. It is found that the results obtained on the basis of extended theory are in better agreement with the experimental values by a few percent than the predictions of the simpler theory of Furry and Jones, which is applicable only to pure monatomic gases. The disagreement between the theory and experiment is still relatively larger than the difference between the results of simple and extended theories. (auth)

28023 ISOTOPIC THERMAL DIFFUSION IN NEON. Laranjeira, M. F.; Cunha, M. Aurea (Comissao de Estudos de Energia Nuclear, Lisbon). Port. Phys., 4: 281-300(1966).

Isotopic thermal diffusion in neon was observed in the temperature range from 335.6 to 507.4°K, which provides a sensitive method to determine the parameter α for the exponential-six model. According to the values obtained and the viscosity data available, a new set of parameters, $\epsilon/k = 33.4$°K, $r_m = 3.144$ Å and $\alpha = 15.5$, is proposed for neon. (auth)

28024 MEASURING ABRASIVENESS OF SOLID FUELS AND OTHER MATERIALS BY A RADIOCHEMICAL METHOD. Goddard, C. W. (Babcock and Wilcox Co., Alliance, Ohio); Duzy, A. F. J. Eng. Power, 90: 186-92(Apr. 1968).

A new method for predicting pulverizer grinding element wear has been developed. A laboratory model, ball-and-race, grinding machine, and a radioactive tracer technique used to determine the relative abrasiveness of solid fuels is described. A procedure for determination of the quartz content of coals was developed, and its relationship to abrasiveness is discussed. Results of testing the abrasiveness of numerous coals and some materials other than coal are presented. A comparison of laboratory abrasion results with actual field wear data is given. Included is a method of application of the experimental wear data to design considerations for new units and also in anticipating wear rates of milling equipment in use. (auth)

28025 ISOTOPIC GENERATOR FOR A DANISH LIGHTHOUSE. Pedersen, E. Storm (Danish Atomic Energy Commission, Riso). Ing. Bygningsv. Ugeovers., No. 46(1966). (In Danish).

A short description of the English RIPPLE program (Radio-Isotope Powered Pulsed Light Equipment) is given. Seven generator prototypes have been produced, and three generators will be lent to England, Sweden, and Denmark, respectively, to be installed in the spring of 1967 for test purposes. (Denm)

28026 NUCLEAR BATTERY. Knight, Robert D. (to International Business Machines Corp.). U. S. Patent 3,344,289. Sept. 26, 1967. Filed Nov. 19, 1965.

A nuclear battery is described which consists of a thin film emitter, electrode of conductive metal, a collecter electrode of thin film, and a separating dielectric film. The emitter electrode is formed by sputtering a conductive metal, such as Al, in the presence of inert ^{85}Kr gas. The battery is arranged in cylindrical shape by winding a combination of emitter film, dielectric, and collecter film. Additional layers of dielectric films serve to separate the collecter and emitter, such as the first collecter from the second emitter. (D.C.C.)

28027 SEPARATION OF FISSION PRODUCTS FROM THERMAL NEUTRON FISSION SOURCES. Armbruster, P.; Eidens, J.; Roeckl, E. (Nuclear Research Centre, Juelich, Ger.). Ark. Fys., 36: 293-304(1967).

From International Symposium on Why and How Should We Investigate Nuclides Far Off the Stability Line, Lysekil, Sweden. See CONF-660817.

The techniques used to separate unslowed fast fission fragments by mass spectrometry were discussed. Ore technique using the gas-filled separator at the KFA–Jülich FRJ-2 reactor was described in greater detail. (B.G.D.)

28028 SURVEY OF ON-LINE ISOTOPE SEPARATOR PROJECTS. Andersson, Goeran (Chalmers Univ. of Tech., Goteburg). Ark. Fys., 36: 61-9(1967).

From International Symposium on Why and How Should We Investigate Nuclides Far Off the Stability Line, Lysekil, Sweden. See CONF-660817.

On-line isotope separator systems are classified as to type of activity and mass analyzer. Relative merits of the various apparatus are briefly discussed. A summary of current projects is given and trends in the development are pointed out. (auth)

28029 SOREQ ON-LINE ISOTOPE SEPARATOR PROGRAM. Amiel, Saadia (Soreq Nuclear Research Center, Yavne, Israel). Ark. Fys., 36: 71-6(1967).

From International Symposium on Why and How Should We Investigate Nuclides Far Off the Stability Line, Lysekil, Sweden. See CONF-660817.

Plans for installing an electromagnetic isotope separator on-line with a fission source at the IRR-1 reactor at Soreq are outlined. Some experimental techniques of special interest and selected research topics are discussed briefly. (auth)

28030 PREPARATION FOR ON-LINE STUDIES OF SHORT-LIVED NUCLEI PRODUCED BY A REACTOR. Talbert, Willard L. Jr.; McConnell, J. R. (Iowa State Univ., Ames). Ark. Fys., 36: 99-105(1967).

From International Symposium on Why and How Should We Investigate Nuclides Far Off the Stability Line, Lysekil, Sweden. See CONF-660817.

The on-line isotope separator system to be used with the Ames Laboratory Research Reactor is described. The initial design for the study of gaseous fission products is given as well as a short description of ion-beam handling equipment to be used between the separator and experimental equipment. Results of transit time measurements for fully simulated on-line operation are presented. (auth)

Materials Testing

Refer also to abstracts 27992, 28008, 28024, 28117, 28247, 28252, 28875, and 28978.

28031 (GEMP-598) DESCRIPTION OF THE PLANE-STRESS AND PLANE-STRAIN SOLUTIONS TO PLATES WITH VARIOUS SIZED CIRCULAR HOLES. COMPUTER PROGRAM (NMP 881). Yalch, J. P. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation). Dec. 1967. Contract AT(40-1)-2847. 67p. Dep. CFSTI.

Described is a Fortran IV computer program, "Plane-Stress and Plane-Strain Solutions to Plates with Various Sized Circular Holes," (NMP 881), based on the method described in a report by T. Slot. This method is suitable for the solution of two-dimensional problems that involve solid or perforated plates with boundary conditions in terms of stresses, displacements, and/or forces. The perforations must be circular but may vary in size. (auth)

28032 (UCRL-13339) SPALLATION THRESHOLDS OF N50A BERYLLIUM. Warnica, R. L. (General Motors Corp., Warren, Mich. Materials and Structures Lab.). Jan. 1968. Contract W-7405-eng-48. 29p. (MSL-68-1). Dep. CFSTI.

For Univ. of California Lawrence Radiation Lab., Livermore.

In the experimental tests to determine the incipient spallation thresholds of N50A beryllium, precisely controlled pulses were obtained by planar impacts of N50A beryllium discs against targets of the same material. Four submicrosecond loading times were investigated and results show this alloy to have time dependent incipient spallation thresholds. The thresholds were determined at impact velocities of approximately 370, 245, 230, and 190 fps for times of loading of 40, 200, 400, and 800 nanoseconds, respectively. (auth)

28033 MOBILE UNIT FOR NEUTRON RADIOGRAPHY. Spowart, A. R. (United Kingdom Atomic Energy Authority, Dounreay, Scotland). Nucl. Eng., 13: 429-31(May 1968).

A neutron radiography unit which is under development is based on an oil moderated sealed tube fast neutron generator coupled to a neutron scintillator–image intensifier viewing system. The image may be viewed by the transfer technique, in which a foil is activated by the neutron beam, or by direct viewing of the image using an image intensifier and television monitor. (UK)

28034 PROTON RADIOGRAPHY. Koehler, A. M. (Harvard Univ., Cambridge, Mass.). Science, 160: 303-4(Apr. 19, 1968).

Energetic protons from an accelerator may be used to produce radiographs showing unusually high contrast but relatively poor spatial resolution. (auth)

Protective Structures

Refer to abstract 27943.

Radioactive Material Handling

Refer also to abstracts 27914, 27979, and 27991.

28035 (BARC-297) CHARACTERISATION OF TROMBAY SOILS FOR DISPOSAL OF RADIOACTIVE WASTES. Godse, V. B.; Mohan, A. L.; Singh, Mahesh; Amalraj, R. V.; Thomas, K. T. (Bhabha Atomic Research Centre, Bombay (India)). 1967. 22p. (CONF-670512-14). Dep.

From Joint IAEA/ENEA Symposium on the Disposal of Radioactive Wastes into the Ground, Vienna, Austria.

Laboratory and field studies were carried out for the characterization of the Trombay soils and ground water to investigate the criteria for safe disposal of radioactive wastes. Physical and chemical properties of the soils were determined in order to evaluate their suitability for retention and leaching characteristics of radionuclides of interest. The soil covering consists of silty clay to clayey type of soil having a base exchange capacity of 34 to 76 meq/100 g. The relative velocity factors for the radionuclides of interest have been evaluated in the laboratory with respect to ground water velocity of the area. Field studies were conducted by establishing a series of bore holes in a grid pattern and field permeability was determined to find out the velocity of ground water in the area. Tracer experiments were also conducted for the rate and direction of ground water movement. An experimental study of direct discharge of solid waste from a chemical plant to the soil environment indicated that there was slight leaching of activity immediately after the monsoon. In view of the prevailing geological, hydrological, and climatic conditions at Trombay area, the general policy followed for ground disposal of radioactive wastes is to contain it in solid form with adequate monitoring and environmental surveillance. (auth)

28036 (DP-MS-67-108) SOME GEOLOGICAL ASPECTS OF RADIOACTIVE WASTE MANAGEMENT. Reichert, Stanley O. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Dec. 8, 1967. Contract AT(07-2)-1. 28p. (CONF-680202-4). Dep. CFSTI.

From 97th Annual Meeting of the American Institute of Mining, Metallurgical and Petroleum Engineers, New York.

At nuclear facilities, three types of radioactive waste must be managed: high-level liquid waste containing fission products from the chemical separation of irradiated uranium; low-level condensates from the concentration of the high-level waste; and dry solids such as obsolete process equipment, spent ion exchange resins, and irradiated metal scrap. The geological and environmental characteristics of a site are important considerations in planning the waste management program. At the Savannah River Plant, low-level liquids and dry solids are safely and economically placed in the soil where the geologic and hydrologic conditions are favorable. Within the general area where the waste originates, studies were made to locate seepage basins and burial grounds in the most favorable sites. At these sites, soils should have a high ion exchange capacity and moderate to low permeability, the

water table should be deep, and the burial sites should be relatively distant from the nearest flowing stream. (auth)

28037 (NYO-841-12) HARVARD AIR CLEANING LABORATORY SEMIANNUAL PROGRESS REPORT, SEPTEMBER 1, 1967-MARCH 1, 1968. First, M. W.; Viles, F. J. Jr.; Reist, P. C.; Bulba, E. A.; O'Brien, M. J.; Weker, R. A.; Goldin, A. S.; Moeller, D. W. (Harvard School of Public Health, Boston, Mass.). Apr. 1968. Contract AT(30-1)-841. 89p. Dep. CFSTI.

Research on air cleaning processes is reported. The major accomplishments were: redesign of a sodium aerosol recirculating system to provide data on the deposition of sodium on the walls of pipes; completion of tests on the use of foams for removing iodine and methyl iodide from reactor containment vessel atmospheres; investigation of copper beads as a filter bed material for removing (and subsequently measuring) iodine removed from ventilating systems of power reactors; initiation of laboratory efforts to evaluate a theory on krypton separation by electrostatic diffusion; construction of a 75 ft^3 steel containment tank capable of retaining air and steam pressures up to 45 psig for cleanup systems; and planning an air cleaning conference on the treatment of airborne radioactive wastes. (L.C.L.)

28038 (ORNL-3358) EVALUATION OF ULTIMATE DISPOSAL METHODS FOR LIQUID AND SOLID RADIOACTIVE WASTES. VI. DISPOSAL OF SOLID WASTES IN SALT FORMATIONS. Bradshaw, R. L.; Perona, J. J.; Blomeke, J. O.; Boegly, W. J. Jr. (Oak Ridge National Lab., Tenn.). May 1968. Contract W-7405-eng-26. 93p. Dep. CFSTI.

The cost of disposing of high-level solidified wastes in bedded salt formations is determined. A conceptual design of a salt mine is developed for disposal of wastes from the recovery of spent uranium and thorium reactor fuels from a 15,000-MW(e) nuclear power economy. The waste products are contained in "pots" 6, 12, and 24 in. in diameter by 10 ft long and are buried in vertical holes in the floor of a mine 1 sq mile in area and located 1000 ft below the surface. The operating life of this mine and the costs of the mining and disposal operations are calculated, using rather conservative mine stability criteria, for various waste ages, pot sizes, and waste compositions. The life of the mine was found to range from about 12½ years for wastes aged 1 year at the time of burial to about 70 years for wastes aged 30 years at burial. The initial capital outlay required to start waste disposal operations ranges from about $8.4 million to $10.7 million. The annual capital and operating costs for the facility are dependent on waste combinations and pot sizes and vary from about $2.6 million for a 1-year-old waste to about $1.2 million for 30-year-old wastes. Using present worth considerations, the money to be set aside annually at the time of waste generation ranges from about $2.5 million for a 1-year-old waste to about $400,000 for a waste 30 years old at the time of disposal. In terms of the cost per kilowatt-hour of electricity generated, these amounts correspond to about 19×10^{-3} mill and 3×10^{-3} mill respectively. (auth)

28039 THE ROLE OF THE COMPETENT AUTHORITY AS ENVISAGED BY THE IAEA TRANSPORT REGULATIONS. van Lokhorst, C. S. H. (Ministerie van Verkeer en Waterstaat, Netherlands). pp 20-43 of Safe Transport of Radioactive Materials. Gibson, R. (ed.). New York, Pergamon Press, Inc., 1966.

The aspects of competent authority involved with packaging designs and transport movements are reviewed. The competent authority as an administrative body is described. Regulations regarding packaging standards are described and provisions for the guarantee that the requirements are met are outlined. (J.C.W.)

28040 CLASSIFICATION OF RADIONUCLIDES FOR TRANSPORT PURPOSES. Fairbairn, A. (United Kingdom Atomic Energy Authority, Harwell, Eng.); Morley, F.; Kolb, W. pp 44-66 of Safe Transport of Radioactive Materials. Gibson, R. (ed.). New York, Pergamon Press, Inc., 1966.

Quantitative limits for amounts of radioactive materials transported in certain types of packaging are classified. The method used to derive the classification of the packaging types necessary for a given radioactive material is discussed. The classification for specific radionuclides and the packaging required for transport are listed. (J.C.W.)

28041 GUIDE TO THE REQUIREMENTS RELATING TO FISSILE MATERIALS. Daniels, J. T. (United Kingdom Atomic Energy Authority, Harwell, Eng.). pp 67-86 of Safe Transport of Radioactive Materials. Gibson, R. (ed.). New York, Pergamon Press, Inc., 1966.

Control of fissile material in transport is to avoid a criticality accident. The regulations contain all the safety criteria for fissile materials and also those applying to other radioactive materials. The labeling and administrative requirements are summarized. Approvals for shipment, design of package, and regulations for storage and transport procedures are explained. Fissile materials included are ^{233}U, ^{235}U, ^{239}Pu, and ^{241}Pu. (J.C.W.)

28042 TESTS FOR TYPE A AND TYPE B PACKAGING AND CAPSULES. Fairbairn, A. (United Kingdom Atomic Energy Authority, Harwell, Eng.); George, T. C. pp 87-112 of Safe Transport of Radioactive Materials. Gibson, R. (ed.). New York, Pergamon Press, Inc., 1966.

Type A packaging requirements are outlined, and testing included the water spray test with impact, free drop test, compression test, and penetration test. Additional tests for Type A packaging for liquids and gases are outlined. Test procedures for Type B packaging include mechanical and thermal testing. For capsule testing, impact, percussion, air heating, and water immersion are specified, followed by leakage testing. (J.C.W.)

28043 DESIGN PRINCIPLES FOR TYPE A AND TYPE B PACKAGING. Grange, A. (United Kingdom Atomic Energy Authority, Harwell, Eng.). pp 113-18 of Safe Transport of Radioactive Materials. Gibson, R. (ed.). New York, Pergamon Press, Inc., 1966.

General construction features are specified, including the attention on temperature variations during transport of radioactive materials. Design principles include areas of shielding, closures, leakproof vessels, pressures, atmospheric changes, insulation, or combinations such as impact after fire. (J.C.W.)

28044 THE IAEA CONCEPT OF THE LARGE RADIOACTIVE SOURCE. Capet, H.; Bouillet, J. (Commissariat a l'Energie Atomique, Paris). pp 119-31 of Safe Transport of Radioactive Materials. Gibson, R. (ed.). New York, Pergamon Press, Inc., 1966.

The regulations of the IAEA regarding packaging are reviewed and deal with routine transport. The radioactive materials must be contained, for maximum safety, in regulatory aggregates. Certain rudimentary limitations, arising from practical design problems in terms of the physical state of the material, the nature of its radiation, and possibly its chemical stage are considered. (J.C.W.)

28045 CARRIAGE OF LOW SPECIFIC ACTIVITY MATERIALS. Wilson, A. R. W. pp 132-46 of Safe Transport of Radioactive Materials. Gibson, R. (ed.). New York, Pergamon Press, Inc., 1966.

The regulations detailed by the IAEA are given for transport of low specific activity for solids, liquids, and surface contaminated material. A detailed tabulation is given of the conditions applying to the transport of low activity materials. External radiation hazards include handling hazard during loading and unloading operations, hazard from occasional approach, and hazard from extended stays in the radiation field. Quantity limits on shipments are discussed. Examples of sea transport discussed are uranium chemical concentrates and monazite. (J.C.W.)

28046 THE CONTROL OF EXTERNAL RADIATION HAZARDS DURING THE TRANSPORT OF RADIOACTIVE MATERIALS. Morley, F. pp 147-79 of Safe Transport of Radioactive Materials. Gibson, R. (ed.). New York, Pergamon Press, Inc., 1966.

The basic safety standards which must be maintained as outlined by the IAEA are discussed. The methods which have been developed to achieve these standards in the transport field are described. External radiation levels for humans, animals, and inanimate objects are discussed. Mathematical models for the calculation of segregation distances from packaged radioactive materials are outlined. The application of radiological protection principles to the determination of segregation distances for persons is summarized. The transit of film by air, land, and sea is discussed. Packaging classification and segregation procedures in the USSR are discussed and tabulated. In an appendix, the estimate of the radioactive traffic factor for air transport from UK is discussed. (J.C.W.)

28047 IATA AND THE CARRIAGE OF RADIOACTIVE MATERIALS BY AIR. Groenewege, A. pp 183-91 of Safe Transport of Radioactive Materials. Gibson, R. (ed.). New York, Pergamon Press, Inc., 1966.

The International Air Transport Association (IATA) was organized to meet technical, traffic, financial, legal, and medical problems created since 1945. The regulations relating to the carriage of restricted articles are discussed. The packaging requirements for restricted articles are outlined and the IATA regulations of radioactive materials carriage are given. (J.C.W.)

28048 IMPLEMENTATION OF THE IAEA REGULATIONS IN THE RID. Bouillet, J. pp 194-212 of Safe Transport of Radioactive Materials. Gibson, R. (ed.). New York, Pergamon Press, Inc., 1966.

The framework of the International Regulations for the Transport of Dangerous Goods (RTD) is discussed. The interaction between the RID and the IAEA is examined and the differences be-

tween the technical requirements are discussed. The divergences between RID and IAEA in the practical application of their safety philosophies are listed. Fitting the duties of the competent authority into the RID format is summarized. (J.C.W.)

28049 IMPLEMENTATION OF THE IAEA REGULATIONS IN THE USA. Rogers, L. R. (Atomic Energy Commission Scientific Representative, Buenos Aires); Barker, R. F. pp 213-25 of Safe Transport of Radioactive Materials. Gibson, R. (ed.). New York, Pergamon Press, Inc., 1966.

Five agencies in the United States have regulations governing the shipment of radioactive materials. The status of the implementation is related to the complex regulatory structure that exists within the USA, the history of development of regulations governing transport, and the size of the transport industry which is affected by changes in the regulations are discussed. (J.C.W.)

28050 IAEA REGULATIONS IN THE UNITED KINGDOM. Clarke, A. W. pp 226-31 of Safe Transport of Radioactive Materials. Gibson, R. (ed.). New York, Pergamon Press, Inc., 1966.

Air, land, and sea regulations are enumerated. The IAEA recommendations fitting the schemes for dealing with the carriage of dangerous goods are summarized for each method of transport. (J.C.W.)

28051 IMPLEMENTATION OF THE IAEA REGULATIONS IN FRANCE. Bouillet, J. pp 232-37 of Safe Transport of Radioactive Materials. Gibson, R. (ed.). New York, Pergamon Press, Inc., 1966.

The development of the regulations for transport of radioactive materials in France is traced. The present status of the regulations is compared with the IAEA pattern. (J.C.W.)

28052 REGULATIONS GOVERNING THE TRANSPORTATION OF RADIOACTIVE MATERIALS IN CANADA. Angus, K. C. pp 238-9 of Safe Transport of Radioactive Materials. Gibson, R. (ed.). New York, Pergamon Press, Inc., 1966.

The agencies controlling production, uses, importing, exporting, and transporting of dangerous materials in Canada are enumerated. A committee was formed to examine the 1961 regulations proposed by the IAEA. (J.C.W.)

28053 REVIEW OF TRANSPORT ACCIDENTS AND INCIDENTS INVOLVING RADIOACTIVE MATERIALS. Goodridge, W. pp 243-54 of Safe Transport of Radioactive Materials. Gibson, R. (ed.). New York, Pergamon Press, Inc., 1966.

The knowledge gained from accident reporting, real or near-misses, can affect needed amendments to regulations regarding the transport of radioactive materials. The accident analyses discussed come from experiences in the United Kingdom and the United States. Tables are presented with varying factors involved in accidents such as accident experience by mode of transportation, location, class of hazard, class of radiological hazard, nature of radioactive material involved, type of outer packaging involved, and estimated standard of packaging used. (J.C.W.)

28054 LIABILITY AND INSURANCE IN THE TRANSPORT OF RADIOACTIVE MATERIALS. Lagorce, M. pp 257-74 of Safe Transport of Radioactive Materials. Gibson, R. (ed.). New York, Pergamon Press, Inc., 1966.

Liability in the field of nuclear transport operations includes discussions on territorial coverage, scope of application, responsibility, limits of liability, exonerations, rules governing jurisdiction, and security. Insurance against civil liability during transport of nuclear materials and proposed legislation by the OECD and IAEA Conventions are discussed. (J.C.W.)

28055 UNITED KINGDOM PRACTICE ON INSURANCE AND INDEMNITY DURING THE TRANSPORT OF RADIOACTIVE MATERIALS. Wright, N. T. pp 275-9 of Safe Transport of Radioactive Materials. Gibson, R. (ed.). New York, Pergamon Press, Inc., 1966.

A review on insurance and indemnity practices in the United Kingdom is outlined. The classes of radioactive shipment materials are summarized. Provisions in insurance and indemnity in all types of accidents are discussed. (J.C.W.)

28056 AN ANALYSIS OF THE IAEA REGULATIONS. Neary, F. J.; Gibson, R. (United Kingdom Atomic Energy Authority, Harwell, Eng.). pp 3-19 of Safe Transport of Radioactive Materials. Gibson, R. (ed.). New York, Pergamon Press, Inc., 1966.

The main provisions of the revived IAEA transport regulations identifying the framework of controls on which the individual requirements are based are summarized. The original transport regulations are listed in an Annex to the chapter. (J.C.W.)

28057 DEACTIVATION PLANT FOR THE WASTE EFFLUENTS AT THE REZ (CZECHOSLOVAKIA) NUCLEAR RESEARCH INSTITUTE. Gabriel, Laszlo. Atomtech. Tajek., 10: 533-41 (1967). (In Hungarian).

Two independent vacuum distillation plants were placed in operation at the Rez Nuclear Research Institute. The first one consisted of batch-type steam-heated boiler, with a capacity to evaporate 200 kg of water per hour. It concentrates the radioactive liquid waste liquors at the lower portion of the evaporator. The second unit, also steamjacketed, operates continuously; the feed is supplied in the form of a spray, at the rate of 130 kg of water per hour. The condensed water is released after measuring its activity and the high-activity concentrate is sent to the burial area for prolonged storage. The combined decontamination factor of the liquors lies between 10^6 and 10^7; the liquors are concentrated by a factor of 50. Adsorption methods were also examined, testing several minerals intended for the deactivation of the low-level waste effluents. Native materials, such as bentonite and peat are proposed to adsorb fission products; electric coagulation methods are also considered. The concentrates are also fixed in concrete, using Portland cement and 20% $NaNO_3$. A special decontamination station was designed to take care of the waste liquors from the radiochemical laboratory. (TTT)

28058 SAFE TRANSPORT OF RADIOACTIVE MATERIALS. Gibson, R. (ed.). New York, Pergamon Press, Inc., 1966. 300p. $12.50.

A total of nineteen chapters is included in the book. A separate abstract was prepared for each of eighteen chapters. The chapter for which no abstract was prepared is concerned with the Intergovernmental Maritime Consultative Organization. (J.C.W.)

For abstracts of individual chapters see: 28039–28056.

Vacuum Engineering

28059 SESSILE DROP STUDY OF LIQUID–SOLID ADHESION FOR THE SYSTEM INDIUM(l)–ALUMINUM USING ULTRAHIGH VACUUM TECHNIQUES. Aldrich, R. G.; Keller, D. V. Jr. (Syracuse Univ., N. Y.). J. Phys. Chem., 72: 1092-9(Apr. 1968).

A sessile drop study was conducted to examine the wetting and adhesion behavior for the system indium–aluminum in the region of bulk immiscibility near the solidification temperature of indium. Ultrahigh purity materials and ultrahigh vacuum techniques were employed to establish contacting surfaces of near atomic cleanliness. The effects of oxygen, nitrogen, and hydrogen on this system over periods of time to 65 hr were observed from ambient pressures of 10^{-10} to 1 torr. The surface tension of liquid indium on a polycrystalline aluminum substrate at 160° in a vacuum of 10^{-10} torr was observed to be 658 (±10%) dynes/cm. The rather large error was presumably caused by the different degrees of liquid interaction with the different crystallographic orientations of the substrate as reflected in the rather large variations in the average contact angle of 120°. The presence of the contaminating gases hydrogen and nitrogen did not significantly affect the observed surface tension of the liquid indium. Oxygen contamination appeared to form an oxide cover on the liquid such that the surface tension of indium appeared to vary with exposure time. The observed adhesion strengths in tension of the indium(s)–aluminum composite at room temperature fell into two distinct and separate classes, e.g., strengths greater than the tensile strength of indium and strengths approaching zero. The former was observed when the interface was formed in ultrahigh vacuum or in an oxygen atmosphere, and the latter was observed when the interface was formed in a hydrogen or nitrogen atmosphere. (auth)

INSTRUMENTATION

Radiation Detection Instruments

Refer also to abstract 29956.

28060 14TH NUCLEAR SCIENCE SYMPOSIUM, LOS ANGELES, CALIF., OCTOBER 31–NOVEMBER 2, 1967. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: 1-504(Feb. 1968). (CONF-671026).

Separate abstracts were prepared for fifty-eight of the seventy papers presented. Twelve papers were previously included in NSA. For abstract numbers of these papers see CONF-671026 in a cumulative report number index. (B.G.D.)

For abstracts of individual papers see: 28072, 28076, 28083–28096, 28098, 28099, 28141–28147, 28149–28152, 28181, 28215, 28216, 28231–28244, 28268, 28987, 28988, 29193, 29306, 29812, 30285, 30286, 30317, 30322, 30355, and 30364.

General Detectors and Monitors

Refer also to abstracts 28264 and 30404.

28061 (AERE-R-5715) ALPHA-TRACK AUTO-RADIOGRAPHY OF SUBMICRON AEROSOL PARTICLES USING THE ELECTRON MICROSCOPE. Heard, M. J.; Wiffen, R. D. (Atomic Energy Research Establishment, Harwell (England)). Feb. 1968. 19p. Dep. CFSTI. UK.

A method is described for applying pre-treated Ilford *L4* photographic emulsion to specimens of radioactive aerosols deposited on electron microscope grids. The resulting preparations are thin enough for electron microscopy and provide a basis for high resolution track autoradiography. Both dry and wet methods have been developed so that materials which are soluble in water can be examined as well as insoluble materials. (auth)

28062 (CEA-Bib-90) METHODES DE FABRICATION DE DETECTEURS AU GERMANIUM ET AU SILICIUM COMPENSES PAR MIGRATION D'IONS DE LITHIUM. (Methods of Fabrication for Germanium and Silicon Detectors with Compensation by Lithium-Ion Drifting). Bornand, Bernard (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Mar. 1968. 74p. (In French). Dep.

A bibliography on the fabrication of germanium and silicon detectors with compensation by lithium-ion drifting is presented. Mounting, packaging, encapsulation, and methods of control for preparation are included, as also resolution and efficiency measurements and spectrometry when the fabrication is concerned. A list of abstracts with references to reviews, reports, thesis, proceedings, and patents (168 references) from 1964 to 1967 (1st semester) with some references at earlier dates (e.g. patents) is given. There are included: subject index, periodical, report and patent number index, and personal author index. In a supplement, twelve abstracts of communications for the 11th Scintillation and Semiconductor Counter Symposium (Washington, Feb. 28–March 1, 1968) are presented. (auth)

28063 (CONF-661020-18) ENSEMBLE A IMPULSIONS POUR LES CONTROLE DES REACTEURS. (Pulse Installation for the Control of Reactors). Buisson, J.; Garau, J. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Aug. 5, 1966. 30p. (In French). Dep.

From 13th Annual Nuclear Science Symposium, Boston, Mass.

An installation to process the pulses delivered by fission chambers, BF_3 counters, and boron-coated proportional counters is described. The pulse amplifier and pulse processing circuits are described. The characteristics of the installation are illustrated by graphs of the pulse forms and discrimination and proportionality curves. (J.S.R.)

28064 (CONF-680207-8) TRANSIENT NONLINEAR RESPONSE OF PLASTIC SCINTILLATORS. Stevens, J.; Knowlen, R. B. (EG and G, Inc., Santa Barbara, Calif.). [1966]. 15p. Dep. CFSTI.

From 11th Scintillation and Semiconductor Counter Symposium, Washington, D. C.

The peak dose rate for which light output is linearly proportional to incident radiation intensity was measured by bombarding 80-ml-thick samples of NE 102 and MEL 150C scintillators with 12-MeV electrons from the EG&G/AEC linear accelerator. To obtain the equivalent gamma dose rate, the sensitivity of the scintillator-photodiode detector used in this work was measured with a calibrated ^{60}Co source. Nonlinear behavior was observed for excitation pulse widths between six nanoseconds and 0.5 microseconds. Analysis of the detector signals indicates that nonlinearity is a function of total dose as well as dose rate. Thus for an excitation pulse width of 0.5 microseconds, scintillator output was found to be linear at the start of the burst, but showed marked nonlinearity by the end of the pulse. The data also indicate that if the dose rate drops below the threshold value after a scintillator is driven into nonlinear operation, the scintillator will continue to behave nonlinearly for some time. The decay time associated with recovery from nonlinearity is greater than 0.5 microsecond. (auth)

28065 (NP-17356) DISENO Y CONSTRUCCION DE UN MEDIDOR DEL NUMERO DE DESINTEGRACIONES POR UNIDAD DE TIEMPO. (Design and Construction of a Rate Meter). Fernandez Parriego, Jorge Eduardo (Instituto Politecnico Nacional, Mexico City. Escuela Superior de Ingenieria Mecanica y Electrica). 1967. 109p. (In Spanish). Dep.

Thesis.

A transistorized rate meter that can be used either with a-c current or with accumulators or a battery was designed and developed. The methods for the detection and determination of the characteristics of radiation are outlined. The principles of the operation of the rate meter are described. The operational characteristics of the rate meter were determined and are reported. (J.S.R.)

28066 (NP-17360) DISENO Y CONSTRUCCION DE UN ESCALADOR PORTATIL TRANSISTORIZADO. (Design and Construction of a Portable Transistorized Scaler). de la Pena Sanchez, Miguel Angel (Instituto Politecnico Nacional, Mexico City. Escuela Superior de Ingenieria Mecanica y Electrica). 1968. 107p. (In Spanish). Dep.

Thesis.

A description is given of the different types of radiation and the most frequently used units. The characteristics of some counter tubes for a wide variety of uses are summarized. A discussion of scintillation counters and a description of photomultiplier tubes for use in such counters is also given. The scalers and special circuits most commonly used for counting chaotic pulses are briefly discussed. The principles of the indicator tube are outlined, and the discharge and ignition of these tubes are discussed in detail. The principles used in the design of the scaler are considered, and the design and characteristics are discussed. An economic evaluation is made of the scaler in comparison with other scalers. (J.S.R.)

28067 (TID-24454) LOW-BACKGROUND BETA DETECTOR SYSTEM FOR SOLID SAMPLE ASSAY. Acuff, Merry Lew (Naval Oceanographic Office, Washington, D. C. Research and Development Dept.). Jan. 1968. Contract AT(49-11)-2955. 25p. Dep. CFSTI.

The design and performance of an anticoincidence-shielded Geiger–Mueller detector system for analysis of low levels of radioisotopes found in the marine environment are presented. Strontium-90 concentrations in sea water from the Barents and Kara Seas using this detector system are also reported. (W.H.K.)

28068 RAPID COMPARATIVE METHOD OF IDENTIFYING BETA-RAY EMITTERS WITH THE USE OF A SCINTILLATION COUNTER. Trusiewicz, Witold; Zarnowiecki, Krzysztof; Pszona, Stanislaw (Inst. of Nuclear Research, Swierk, Poland). Nukleonika, 13: 215-22(1968).

A rapid method of identifying beta-ray emitters has been developed. The method is based on comparing pulse rates from an unknown and a standard emitter. The measurements are made by means of a scintillation counter at equal pulse amplitude discrimination levels for both preparations. For approximate determination of the energy of single simple beta emitters it is sufficient to perform the measurements at two different discrimination levels. If a more accurate determination of a single simple beta spectrum energy or of separate component energies of complex beta spectra originating from one or several radionuclides is required, the measurements should be performed at a greater number of discrimination levels. The method allows to determine beta-ray energies, E_β, by measuring either thick or thin preparations with a wide activity range. It is also possible to determine the percentual composition of mixtures of beta emitters. (auth)

28069 LOW BACKGROUND BETA SCINTILLATION COUNTER. Pszona, Stanislaw; Zarnowiecki, Krzysztof (Inst. of Nuclear Research, Swierk, Poland). Nukleonika, 13: 223-8 (1968).

A low scintillation counter for counting with a mean background count rate of 0.17 cpm at a 120 keV discrimination level has been constructed. The analysis of the background sources is given. (auth)

28070 SPECTROMETER FOR STUDYING ATOMIC COLLISIONS IN THE ENERGY RANGE 5 TO 100 keV. Woolley, R. L.; Warner, A. G.; Poole, D. H.; Hancock, R. (Central Electricity Generating Board, Berkeley, Eng.). pp 279-81 of Heavy Particle Collisions. London, Institute of Physics and Physical Society, 1968.

From Conference on Heavy Particle Collisions, Belfast. See CONF-680415.

An ion energy spectrometer is described for measuring the differential scattering cross section of selected atom pairs, and the associated energy loss. This information is required in connection with radiation damage studies. A time-of-flight method is used for energy analysis, so that the scattered atoms or ions can be detected whatever their charge state. (auth) (UK)

28071 SCINTILLATION GAMMA CAMERA WITH A CsI(Rb) IMAGE-FORMING CRYSTAL. Osipov, I. S.; Ovchinnikov, A. M.; Shcherbakov, L. M. Izv. Akad. Nauk Arm. SSR, Ser. Tekh. Nauk, 19: No. 6, 35-41(1966). (In Russian).

A scintillation camera designed for the detection of tagged tracer atoms in human organisms was developed. The camera utilizes a Rb-doped CsI single crystal as detector, organic glass light pipe, six photomultipliers, amplifiers, and a power supply. A block diagram of the camera is presented. The scintillation properties of CsI crystals doped with 0.75-1% of Cd, Cu, Br, Ba, Rb, and Tl respectively were studied. The scintillation response was determined in terms of the ^{131}I gamma spectrum and the experimental results are summarized in graphs and tables. It was found that CsI(Br) gave the best resolution; however, because it is difficult to grow large single crystals of CsI(Br), the next best scintillator, CsI(Rb), was chosen for the construction of the gamma-camera. A short discussion of the factors affecting the sensitivity and resolution of the camera is presented. (ATD)

28072 THE PERFORMANCE OF A COUNTING-MEAN-SQUARE VOLTAGE CHANNEL IN THE EBR-II. Popper, Glenn F.; Harrer, Joseph M. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: 22-7(Feb. 1968).

From 14th Nuclear Science Symposium, Los Angeles. See CONF-671026.

A wide range neutron flux monitoring test channel based on counting and mean-square voltage techniques has been installed at the EBR-II. The measured responses to neutron flux are presented and compared to those predicted. Data taken while the reactor is on an essentially constant period during typical restarts are shown. The gamma discrimination ratio for this system has been determined and is discussed. (auth)

28073 SIMPLE ON-LINE PARTICLE IDENTIFICATION SYSTEM. Alderson, P. R.; Bearpark, K. (Univ. of Liverpool). Nucl. Instrum. Methods, 62: 217-20(June 15, 1968).

A simple on-line particle identification system has been developed for use with the Digital Equipment Corporation PDP-7 computer. Use is made of the direct relationship between stopping power and particle energy, without the necessity of introducing multiplicative constants to correct for logarithmic terms in this relationship. The technique has been successfully employed in the study of a number of direct reactions which yield complicated particle spectra. (auth)

28074 FOUR-DETECTOR APPARATUS FOR MEASURING γ-γ ANGULAR CORRELATIONS. Walter, H. K.; Weitsch, A. (Technische Hochschule Darmstadt, Ger.). Nucl. Instrum. Methods, 62: 189-98(June 15, 1968). (In German).

A 4-detector apparatus for measuring γ-γ angular correlations and magnetic moments of short lived nuclear excited levels is described. Each detector can accept each one of the two cascading γ-rays. The coincidences of the 12 possible combinations are measured by time-to-amplitude converters and recorded by a multichannel analyzer. The evaluation of the data is described and also a method to find the most sensitive angular positions of the 4 detectors. (auth)

28075 DIGITAL WINDOWS FOR γ-γ COINCIDENCE MEASUREMENTS WITH SEMICONDUCTOR DETECTORS. Tharun, U.; Kaffrell, N. (Univ., Mainz). Nucl. Instrum. Methods, 62: 184-8 (June 15, 1968). (In German).

Digital windows have been designed and built to avoid the disadvantages of normal single channel analyzers setting the gate in γ-γ-coincidence experiments with two Ge(Li)-detectors. (auth)

28076 EXTENDED CAPABILITY FOR FAST NEUTRON HODOSCOPE USED AT TREAT. De Volpi, A.; Pecina, R.; Freese, C. H.; Rolnicki, E.; Travis, D.; Larsen, G. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: 77-86(Feb. 1968).

From 14th Nuclear Science Symposium, Los Angeles. See CONF-671026.

The fast neutron hodoscope used at TREAT reactor for fuel meltdown studies has been improved to permit count rates above 10^6/sec in each channel. Also a digital readout system, based on integrated circuit scalers, has been introduced. Peak instantaneous data rate capability, now about 10^7/sec, can be expanded to 10^9/sec. (auth)

28077 DETECTION OF HEAVY CHARGED AND NEUTRAL PARTICLES. Daly, N. R.; Powell, R. E. (Atomic Weapons Research Establishment, Aldermaston, Eng.). pp 261-5 of Heavy Particle Collisions. London, Institute of Physics and Physical Society, 1968.

From Conference on Heavy Particle Collisions, Belfast. See CONF-680415.

For many measurements in ion physics it is necessary to record singly charged and neutral particles. If the particles are very energetic, they can easily be detected directly in solid-state counters or in scintillators. In the tens of kilovolt range and below, however, electron multipliers are usually used and the detection efficiency can vary rapidly with energy. The most important factor in determining the efficiency in this type of multiplying system is the first stage gain. The particle releases secondary electrons according to a Poisson distribution law, $P_x = m^x/x)\ e^{-m}$ where P_x is the probability of observing x secondary electrons released when the mean number is m. Thus, with m = 1, 60% of the particles will remain undetected. Detectors developed at AWRE for charged and neutral particles are discussed; these are highly efficient because at the first stage high secondary electron coefficients have been achieved. The detectors are simple to construct, have very stable gains, and can operate into very low noise levels. (auth) (UK)

28078 REDUCTION OF COSMIC BACKGROUND IN AN X-RAY PROPORTIONAL COUNTER THROUGH RISETIME DISCRIMINATION. Gorenstein, Paul; Mickiewicz, Stanley (American Science and Engineering, Cambridge, Mass.). Rev. Sci. Instrum., 39: 816-20(June 1968).

The method of background reduction by risetime discrimination has been applied to a large area proportional counter for use in an x-ray astronomy observation from a sounding rocket. Analysis of data from a recent flight has shown the system to be about 90% effective in reducing the non-x-ray background observed in the space environment for the energy range 3-10 keV that persists when anticoincidence guard counters are used while at least 80% of the x-ray efficiency is retained. The system is simple, compact and does not require any critical components. (auth)

28079 NONDESTRUCTIVE THICKNESS MEASUREMENT IN THIN SECTIONS OF GERMANIUM. Mittleman, S. D.; Bess, L. (Electronics Research Center, Cambridge, Mass.). Rev. Sci. Instrum., 39: 838-40(June 1968).

A system for performing infrared absorption measurements using a laser source is described which allows the accurate determination of thicknesses of thin sections of germanium in the range of 4 to 10 μ. The advantages in the use of a laser in lieu of a polychromatic source are (1) only two calibration points need be made, (2) output power of the radiation source need not be regulated, and (3) small areas may be measured using only simple optics. The overall accuracy of the system yields an error less than 6%. (auth)

28080 NOMOGRAM FOR RADIOACTIVITY COUNTING STATISTICS. Rigas, Demetrios A. (Univ. of Oregon, Portland). Int. J. Appl. Radiat. Isotopes, 19: 453-7(May 1968).

A nomogram with expandable range was developed for determining counting times, fractional errors, confidence levels, factors of merit, and for optimizing spectrometer settings in radioactivity counting. A special plastic ruler (nomogram reader) was constructed which facilitates the use of this and other nomograms and graphs. (auth)

28081 DOUBLE RATIO TECHNIQUE AS AN AID TO SELECTION OF SAMPLE PREPARATION PROCEDURES IN LIQUID SCINTILLATION COUNTING. Bush, E. T. (Nuclear-Chicago Corp., Des Plaines, Ill.). Int. J. Appl. Radiat. Isotopes, 19: 447-52(May 1968).

Adsorption or precipitation of radioactive material from liquid scintillation solutions leads to errors in determining activity, even when phase separation is not visually apparent. Such errors can readily be detected by a double ratio technique, leading to rapid identification of unsuitable sample formulations. Determination of counting efficiency in nonhomogeneous samples is discussed. (auth) (UK)

28082 AUTOMATIC REAL TIME AIR MONITORING OF ^{85}Kr UTILIZING THE 4096 MEMORY OF A MULTIPARAMETER ANALYZER. Ludwick, J. D.; Lashock, J. J.; Connally, R. E.; Nickola, P. W. (Battelle Memorial Inst., Richland, Wash.). Contract AT(45-1)-1830. Rev. Sci. Instrum., 39: 853-9(June 1968).

A noble gas atmospheric monitoring field grid system in which ^{85}Kr is used as a tracer has been designed, constructed and implemented for studying atmospheric transport and diffusion. This system has demonstrated its usefulness in the quantitative measurement of the transport and diffusion of both continuous and true puff-type radioactive gas releases on a real-time basis. Small fluctuations in the air concentrations of the tracer are determined by using integrating times of as little as 1 sec. The system consists of a large group of field detectors which relay their information to a 4096 address memory. The memory is presently programmed to accept information from 64 detectors. Information is accumulated in groups of 64 time channels and these groups are automatically stepped by the programmer. A time interval selector allows automatic advance of the stepping process at a slow or fast rate allowing the desired differential data accumulation. The memory is read out on magnetic tape and the equipment is ready for the next field test 35 sec after completion of a tracer field test. (auth)

28083 LOW-ENERGY ELECTRON POSITION SENSOR. Reinitz, Karl (Westinghouse Electric Corp., Baltimore). Contract NAS5-3446. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: 352-61(Feb. 1968).

From 14th Nuclear Science Symposium, Los Angeles. See CONF-671026.

A surface barrier diode for position determination of low energy electrons was fabricated on a 1″ diameter, .006″ thick 2000 Ω-cm resistivity N type silicon slice with the active sensor area occupying about ½″ by ½″ of the area in the middle of the wafer. The sensitive front side of the unit consisted of a gold plated p-type inversion layer while the reverse side had a contact array on it providing position readout. This array was made up of two perpendicular sets of parallel evaporated conductors mutually isolated from each other. A unit having 32 readout lines in each of the X and Y directions was completed and it was shown that a sensor with 64 lines in each of the above directions can also be made with the technique currently in use. The units were tested using an electron gun and an accelerating potential providing up to 50 KV. This unit with its readout arrangement provides a unique scheme capable of position determination of low energy electrons with the minimum number of readout channels and readout complexity. For this reason, the above mosaic was combined with a uv photocathode and a suitable accelerating potential in a vacuum envelope. The tube, when completed, was capable of sensing extremely low intensity uv flux, down to possibly a few photons per second. Upon the incidence of low intensity uv flux, electrons are emitted from the photocathode. These electrons are then accelerated and focused onto the silicon mosaic and are detected there as a pulse. The sensitivity of the photocathode decayed as the time went on, however, the tube operated with a sufficient sensitivity for over a month to make evaluations possible. The tube is aimed for space use and there the confining envelope can be omitted so that the life of the spaceborne experiment is longer than indicated above. However, to increase the tube life in case the envelope is present the unit should be designed without any epoxy. This would prevent the early contamination of the photocathode and prolong the lifetime of the tube. Finally, a comparison of the hybrid tube approach (the semiconductor element and photocathode in a vacuum envelope) with the electronographic method (film used in conjunction with a photocathode) is given. (auth)

28084 GAMMA DISCRIMINATION AND SENSITIVITIES OF AVERAGING AND RMS TYPE DETECTOR CIRCUITS FOR CAMPBELLING CHANNELS. Thomas, H. A.; McBride, A. C. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: 15-21(Feb. 1968).

From 14th Nuclear Science Symposium, Los Angeles. See CONF-671026.

Experiments are described in which the performance of a linear type detector circuit is compared with a mean square type detector circuit for Campbell measurements. The need for pulse overlap is demonstrated for the linear type detector which requires a minimum angular cutoff frequency, ω_L, equal to the lowest desired pulse rate. Measurements with the two types of detector circuits in a high gamma background and measurement of gamma and neutron sensitivities indicate a gamma discrimination figure of merit of 5 R per hr/nv. Application of counting and Campbelling techniques to a single ten decade log channel is described along with an electronic combining circuit for producing a single continuous output of such a channel. (auth)

28085 A GAMMA COMPENSATED NEUTRON IONIZATION CHAMBER DETECTOR FOR THE NERVA REACTOR. Todt, William H. (Westinghouse Electric Corp., Elmira, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: 9-14(Feb. 1968).

From 14th Nuclear Science Symposium, Los Angeles. See CONF-671026.

A compensated ionization chamber, the WX-5362, has been developed for use in the NERVA program as a neutron flux detector for reactor control. The chamber has been designed to withstand the extremes of radiation, temperature, shock and vibration associated with the NERVA reactor. (auth)

28086 FOUR PARAMETER E vs dE/dx AND TIME-OF-FLIGHT COMPUTERIZED CHARGED PARTICLE EXPERIMENT. Bertrand, Fred E. (Oak Ridge National Lab., Tenn.); Burrus, Walter R.; Hill, Nathanial W.; Love, Temple A.; Peelle, Robert W.; Rust, Bert W. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: 145-9(Feb. 1968).

From 14th Nuclear Science Symposium, Los Angeles. See CONF-671026.

For detection of charged particles from 1 to 60 MeV, three solid state detectors are utilized in a dE/dx telescope configuration. Signals are summed digitally and displayed on a 2-dimensional flicker box and transmitted off-line to a larger computer for tail corrections, dead layer corrections, and final analysis. Time-of-flight is utilized for nonpenetrating particles. p, D, T, ^3He, α, etc. can be distinguished from 1 to 60 MeV with ~180 keV system energy resolution. (auth)

28087 CHARGE COLLECTION EFFICIENCIES FOR LITHIUM-DRIFTED SILICON AND GERMANIUM DETECTORS IN THE X-RAY ENERGY REGION. Zulliger, H. R.; Aitken, D. W. (Stanford Univ., Calif.). Contract AF49(638)-1499. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: 466-74(Feb. 1968).

From 14th Nuclear Science Symposium, Los Angeles. See CONF-671026.

Theoretical calculations showing the charge collection efficiencies of Ge(Li) and Si(Li) planar detectors as a function of trapping lengths and incident x-ray energies are presented. It is demonstrated that there should be an intrinsic energy dependence of the charge collection efficiency for radiation lengths comparable to the detector depletion depth. The nonlinear behavior is generally greater for unequal hole and electron trapping lengths. Experimental results confirm this in part, but surface effects appear to accentuate the effect. It is concluded that, neglecting surface effects, the nonlinearities should be eliminated if the radiation is incident in a direction perpendicular to the field. Highest charge collection efficiency, best resolution and linearity are obtained by injecting the photons through the detector side (perpendicular to the field) along a unique plane which is defined by the electron to hole trapping ratio. (auth)

28088 PULSE HEIGHT DEFECTS DUE TO NUCLEAR COLLISIONS MEASURED WITH THIN WINDOW SILICON SURFACE BARRIER DETECTORS. Forcinal, G.; Siffert, P.; Coche, A. (Centre de Recherches Nucleaires, Strasbourg). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: 475-81(Feb. 1968).

From 14th Nuclear Science Symposium, Los Angeles. See CONF-671026.

Nuclear collisions undergone by an ion in a detector introduce a lack of ionization called pulse-height defect, the importance of which varies with energy and type of particles. This defect has been measured for He, N and Ne ions with energies below 150 keV impinging on a gold silicon surface barrier detector. The results are compared with Lindhard's and Haines's theories and are in good agreement. (auth)

28089 TIME RESOLUTION OF PLANAR Ge(Li) DETECTORS IN $\gamma-\gamma$ COINCIDENCE EXPERIMENTS. Balland, J. C.; Pigneret, J.; Samueli, J. J.; Sarazin, A. (Univ., Lyon). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: 411-22(Feb. 1968).

From 14th Nuclear Science Symposium, Los Angeles. See CONF-671026.

In the first part, the shape of the charge and current pulses issued from the single photoelectric interaction of a gamma-ray with the atoms of a Ge(Li) detector is calculated. This shape depends on the interaction abscissa and on the range of the secondary electron. The influence of the latter is well seen on the shapes of the pulses presented. The distribution of risetime is deduced from this calculation. In the second part, the distribution of the time at which the signal crosses a threshold is calculated by means of a suitable mathematical transformation (it is the time spectrum of a leading edge timing). Electronic noise is taken into account and the variations of the calculated distributions versus noise, threshold and range of secondary electrons are presented. Discussions about an improvement of the time

resolution are included in this part and it is shown that a very simple filter can ameliorate the accuracy of the measurement. In the third part the experimental set-up is described. The variations of time resolution versus detector bias voltage are presented. The variations of time resolution versus threshold are also shown and one of these curves is compared with the calculated one. Agreement is not perfect but can explain some irregularities of the experimental distributions. The disagreement between calculated and experimental curves must be attributed to the assumption of the single photoelectric interaction. In the fourth part, the possibility of multiple interactions in a Monte Carlo program is taken into account. The results of pulse shape distributions are compared with those given by the previous model and the effects of multiple interactions are clearly appearing. (auth)

28090 TEMPERATURE DEPENDENCE OF THE AVERAGE ENERGY PER ELECTRON-HOLE PAIR FOR GAMMA RAYS IN Ge(Li) DETECTORS. Sakai, E. (Atomic Energy of Canada Ltd., Chalk River, Ont.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: 432-7(Feb. 1968).

From 14th Nuclear Science Symposium, Los Angeles. See CONF-671026.

The relative average energy per electron-hole pair $\epsilon_T/\epsilon_{77°K}$ has been measured over the temperature range 10 to 170°K in four Ge(Li) detectors irradiated with 662 keV γ-rays. The change in apparent ϵ with temperature was small and, over the temperature range 25 to 170°K, varied between 1.0 and 2.2% for the four detectors — a much smaller variation than that reported by Emery and Rabson. (auth)

28091 SURFACE TREATMENT OF GERMANIUM–LITHIUM DIODES. McKenzie, J. M. (Bell Telephone Labs., Inc., Whippany, N. J.); de Wit, R. C. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: 444-7(Feb. 1968).

From 14th Nuclear Science Symposium, Los Angeles. See CONF-671026.

Several surface treatments are described which change the I-V characteristics of lithium-drifted germanium diodes. These treatments, applied after the final etch, have reduced the diode leakage current to $<10^{-9}$ A for fields of up to 600 V/mm. Treatments achieving this on several diodes are described. (auth)

28092 LITHIUM DRIFTABILITY IN GERMANIUM. Lopes da Silva, G.; Henck, R.; Kuchly, J. M.; Siffert, P.; Coche, A. (Centre de Recherches Nucleaires, Strasbourg). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: 448-55(Feb. 1968).

From 14th Nuclear Science Symposium, Los Angeles. See CONF-671026.

Evidence of the role played by high concentration of oxygen or vacancies in the driftability of lithium in the crystals is made by precipitation studies. The results obtained are confirmed by other experiments: minority carrier mobility, diffusion constant of lithium, and influence of copper. (auth)

28093 RESPONSE OF LITHIUM-DRIFTED SILICON RADIATION DETECTORS TO HIGH-ENERGY CHARGED PARTICLES. Aitken, D. W.; Emerson, D. W.; Zulliger, H. R. (Stanford Univ., Calif.). Contracts AF49(638)-1593; Nonr 225(67). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: 456-65(Feb. 1968).

From 14th Nuclear Science Symposium, Los Angeles. See CONF-671026.

The measured response characteristics of lithium-drifted silicon radiation detectors at 295 and 79°K are presented for protons with energies from 315 to 3.5 MeV; for positive pions with energies from 50.2 to 206 MeV; and for electrons with energies from 265 keV to 767.2 MeV. Analysis of the energy loss spectra confirms that the energy is being deposited by the protons and pions in the silicon purely through collision losses, whereas it appears that the silicon absorbs additional energy lost by the high energy electrons through interaction of the bremsstrahlung radiation in the depletion region. The charge collection efficiency determined by gamma rays is shown to agree with the charge collection efficiency determined by minimum ionizing particles. Nonlinear effects caused by unequal electron and hole trapping lengths and surface effects lead to reduced charge collection efficiencies for low energy electrons which do not completely penetrate the detector depletion region, in agreement with theory and with observations in the x-ray region. Apparent recombination effects also lead to reduced charge collection efficiencies at low fields or for protons with energies below about 100 MeV under constant bias conditions. The present data support the conclusion that the charge conversion factor ϵ at any one temperature is constant to within 1% for electrons, pions and protons over the entire energy span measured. (auth)

28094 SATELLITE INSTRUMENTATION FOR CHARGED PARTICLE MEASUREMENTS. I. ELECTROSTATIC ANALYZER FOR 1 TO 100 keV PARTICLES. Paolini, F. R.; Theodoridis, G. C.; Welsh, W. F. (American Science and Engineering, Cambridge, Mass.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: 188-93(Feb. 1968).

From 14th Nuclear Science Symposium, Los Angeles. See CONF-671026.

A low energy proton and electron electrostatic analyzer has been built for use in trapped particle measurements aboard Air Force satellites. The basic design features of the instrument are described as well as the calibration of the plate assembly for particle transmission, of the magnetic electron multiplier sensor for relative efficiency to electrons and protons of various energies, and the final calibration of the assembled instrument utilizing electron and proton guns and distributed radioactive sources. (auth)

28095 FAST NEUTRON–GAMMA DETECTOR FOR SPACE RESEARCH. St. Onge, R. N.; Lockwood, J. A. (Univ. of New Hampshire, Durham). Contract NASr-164. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: 264-7(Feb. 1968).

From 14th Nuclear Science Symposium, Los Angeles. See CONF-671026.

The unique features of this instrument are the following: the charged particle shield (NE 102) uses only two PM tubes, the 4π charged particle shield encloses completely the neutron-gamma detector, all PM tubes and associated sensor electronics, the pulse shape discriminator (PSD) is passive and miniature, with $M > 3.1$ at the ^{60}Co Compton edge, the separate spectra of neutrons ($1 < E_n < 20$ MeV) and gammas ($1 < E_\gamma < 7$ MeV) are extracted. The IFC (4% resolution) with PSD on NaI(Tl & ^{241}Am) is also displayed with (4). The quality of data is checked by parity bits, and data are transmitted by a parallel, redundant FM– FM TM system. (auth)

28096 INSTRUMENT FOR THE MEASUREMENT OF CHARGED PARTICLES IN THE AURORA. Alexander, R.; Bernstein, W.; Sanders, N.; Wax, R. (TRW Systems, Redondo Beach, Calif.). Contract NASw-1474. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: 258-63(Feb. 1968).

From 14th Nuclear Science Symposium, Los Angeles. See CONF-671026.

A single electrostatic analyzing instrument has been developed that allows multiple channel energy analysis for both protons and electrons. Circuitry for this instrument maximizes temporal resolution with telemetry bandwidths over a 5 decade count rate range. The instrument measures energies of 1 to 20 keV in 5 energy intervals at count rates of 1 to 10^5 counts/sec with a maximum temporal resolution of 10^{-2} seconds. (auth)

28097 METHOD OF MEASURING NANOSECOND ISOMERIC STATES PRODUCED IN (PARTICLE,xn) REACTIONS. Yamazaki, T.; Ewan, G. T. (Univ. of California, Berkeley). Nucl. Instrum. Methods, 62: 101-4(June 1, 1968).

A simple method for measuring the lifetimes of gamma-transitions from nanosecond isomeric states is described. The method depends on the phase grouping of beam pulses in a cyclotron and the fast timing properties of Ge(Li) detectors. (auth)

28098 CHANNEL ELECTRON MULTIPLIER AS AN ALPHA DETECTOR. Kaiser, W. C.; Managan, W. W.; Mayer, T. A. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: 498-502(Feb. 1968).

From 14th Nuclear Science Symposium, Los Angeles. See CONF-671026.

The response of Bendix CEM 401 channel electron multipliers to a hot filament electron source and a ^{244}Cm alpha source has been investigated. This investigation shows that a CEM operated in the saturated mode produces output pulses for alpha particles which are, on the average, about twice the height of those for single electrons. A series of pulse height distribution curves obtained with various alpha absorbers and electric field potentials between the source and CEM are presented to substantiate this conclusion. (auth)

28099 SATELLITE INSTRUMENTATION FOR CHARGED PARTICLE MEASUREMENTS. III. SCINTILLATION SPECTROMETER FOR RELATIVISTIC ELECTRONS. Paolini, F. R.; Theodoridis, G. C.; Welsh, W. F. (American Science and Engineering, Cambridge, Mass.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: 200-4(Feb. 1968).

From 14th Nuclear Science Symposium, Los Angeles. See CONF-671026.

A scintillation spectrometer for OV1-13 is described. Scintillation pulses are accepted for differential analysis only if in coincidence with appropriate energy depositions within an associated dE/dx detector. This allows accurate measurement of

electrons in the presence of high intensities of hard protons. The dE/dx detector and additional logic reduce spectrometer sensitivity by 80%, and broaden resolution to 50%. The geometrical factor is 1.0×10^{-2} cm^2-ster. (auth)

28100 FAST INORGANIC SCINTILLATOR. Luckey, D. (Massachusetts Inst. of Tech., Cambridge). Nucl. Instrum. Methods, 62: 119-20(June 1, 1968). (MIT-2098-409).

Measurement of the scintillation of ZnO: Ga by α-particles show a greater light output than plastic organic scintillators with a decay time of 0.4 ± 0.15 nsec. (auth)

28101 NUCLEAR INSTRUMENTS OVER THE LAST FIFTY YEARS. Kandiah, K. (Atomic Energy Research Establishment, Harwell, Eng.). J. Phys. E, 1: 369-72(Apr. 1968).

A series of articles concerning various aspects of nuclear instrumentation over the last 50 years is presented. (auth)

28102 ATTENUATION: AS A FUNCTION OF DISTANCE, OF THERMAL FLUX PRODUCED BY A MONOENERGETIC POINT SOURCE OF FAST NEUTRONS IN HYDROGENOUS MEDIA. APPLICATION TO CALCULATION OF THE EFFICIENCY OF A NEUTRON COUNTER. Le Bars, M.; Picot, A. (Faculte des Sciences, Nancy, France). Rev. Phys. Appl., Suppl. J. Phys., 3: 53-8(May 1968). (In French).

A simple theoretical method is given for calculating the variation of thermal flux produced by a point source of fast neutrons placed in a slowing down medium with finite or infinite dimensions. It employs a line of argument deduced from the multigroup method in which only a fast group is considered, then the classical scattering equation is solved in spherical symmetry. The result is applied to calculate a neutron counter efficiency variation versus the energy. The theoretical curves obtained have been verified experimentally in another paper. (auth)

28103 GOALS OF THE NUCLEAR INSTRUMENT DEVELOPMENT ACTIVITIES AT THE GAMMA WORKS. Maschek, Tivadar. Atomtech. Tajek., 10: 509-13(1967). (In Hungarian).

Manufacture of nuclear instruments at the Gamma Works was started in 1957. The following guidelines were followed in the establishment of the development program: mobilization of all available technological resources needed to make available the instruments required for the widespread use of radioisotopes; development of a complete line of instruments needed for medical and agricultural applications; and increase in the reliability of the instruments. The current program includes a family of transistorized scintillator heads, proposing to broaden the series of soft γ scintillators and liquid scintillators in the near future. In addition to large NaI(Tl) crystals, additional low-background scintillators will be developed. Special attention will be devoted to semiconductor detectors. Laboratory instruments will be based on standardized units. The industrial instruments program emphasizes telemetering units operating on the isotopic principle. The radiation-protection program is more modest; no personnel monitoring devices are currently manufactured. The program will be completed by 1971. (TTT)

28104 TIME-SAMPLING AMPLIFIER. Goldsworthy, W. (Univ. of California, Berkeley). Nucl. Instrum. Methods, 62: 93-100(June 1, 1968). (UCRL-17904).

A time-sampling and logic-program approach has been applied to a nuclear-event-processing amplifier system in order to provide excellent low- and high-counting-rate energy-resolution performance. This approach has also permitted practical inclusion of low-level input spectral subtraction having great simplicity and little loss of high-rate energy resolution. (auth)

28105 ABSOLUTE NEUTRON FLUX DETERMINATION BY A BACK-TO-BACK FISSION CHAMBER AND ACTIVATION DETECTORS. Maracci, G.; Rustichelli, F.; Aiello, V.; De Lillo, T. (EURATOM-CCR, Ispra, Italy). Nucl. Instrum. Methods, 62: 57-60(June 1, 1968).

A method for the absolute determination of the neutron flux, by using a back-to-back fission chamber and Au as activation detector is presented. The results of measurements executed in the RB-2 reactor of Bologna are compared with $4\pi\beta$ counting technique determinations using Mn activation detectors: the agreement is satisfactory. The estimated total error in the absolute flux value obtained is ±1.5%, including the ±0.7% error in the thermal fission cross section of ^{235}U. (auth)

28106 C_λ VALUES FOR HIGH ENERGY X-RADIATION. Almond, P. R. (Univ. of Texas, Houston). Phys. Med. Biol., 13: 285-6(Apr. 1968).

Comments are made on the papers and correspondence by Greene and Massey (Phys. Med. Biol. 11: 569(1966) and 12: 257 (1967)) in which some discrepancies are pointed out. (UK)

28107 INSTRUMENTAL BACKGROUND IN X-RAY ASTRONOMY MEASUREMENTS. Brini, Domenico; Ciriegi, Umberto; Fuligni, Franco; Moretti, Elena (Univ., Bologna). Ric. Sci., 37: 929-31(Nov. 1967).

The importance of the instrumental background in cosmic x-ray measurements is emphasized, with particular reference to the contribution due to the x-ray production in the detector by charged particles. If no suitable device, cancelling or at least decreasing this contribution, operates on the x-ray detector the instrumental background may be comparable to or greater than the true x-ray intensity to be measured. An experiment to evaluate such a contribution in our x-ray detector, in an energy range from 10 to 200 keV, has been performed by means of balloon flight. The results show that the local x-ray production, when it is not cancelled, is much greater than the intensity of the true x-rays detected. (auth)

28108 A HEXAFLUOROBENZENE GAMMA DOSIMETER FOR USE IN MIXED NEUTRON AND GAMMA FIELDS. Wait, G. D. (Defence Research Board, Ottawa). Nucl. Appl., 4: 440- (June 1968).

A high-sensitivity dosimeter system was developed to measure low gamma-ray dose rates in the presence of neutrons. The detector is a liquid scintillator that employs hexafluorobenzene (C_6F_6) as a solvent and is practically hydrogen free. The energy absorbed in the scintillator is determined directly by counting the analog-to-digital converter pulses of a multichannel analyzer in a fast scaler. The ratio of energy absorbed to air exposure dose was measured for incident gamma energies of 0.06 MeV (^{241}Am), 0.66 MeV (^{137}Cs), 1.25 MeV (^{60}Co), and 4.43 MeV (^{241}AmBe) and gave an average deviation of 3.5% from a constant ratio of energy absorbed to air exposure. A Monte Carlo computer program was written to determine the response of the scintillator to a broader range of gamma-ray energies. This indicated that the ratio of the energy absorbed to the air exposure would vary within the limits of ±10% from 50 keV to 10 MeV. The response to fast neutrons also was measured and compared with calculations which showed that the major component in the neutron response was produced by β^- decay following the (n,α) reaction in ^{19}F. For the broad spectrum of incident fast neutrons (up to 11.5 MeV) from a ^{241}AmBe source, the neutron response of the dosimeter was found to be <8% of its response to the comparable flux of 4.43 MeV gamma rays from the source. (auth)

28109 BACKGROUND RATES IN TRITIUM COUNTING: THE EFFECT OF THE VIAL. Paix, D. (Prince Henry Hospital, Little Bay, Australia). Int. J. Appl. Radiat. Isotop., 19: 162-4 (Feb. 1968).

When specimens are assayed by liquid scintillation counting the radioactivity of the vial may contribute significantly to the background count-rate. This contribution may vary markedly between vials of differing type, or even between vials from a supposedly uniform supply. These effects limit the precision with which the net count-rates can be established when (as is usual) a single blank is made to serve as background for a number of samples. The effect in a counter set to a tritium channel was investigated by counting a large number of specimens consisting of 10 ± 0.1 ml of Bray's mixture in glass and polythene vials. Each was counted for 30 min (except where otherwise stated). Three types of polythene and glass vials were examined. Wide variations were found. (auth)

28110 LUMINESCENCE DECAY TIMES OF ULTRAVIOLET-EXCITED SCINTILLATOR SOLUTIONS. Amata, C. D.; Burton, M.; Helman, W. P.; Ludwig, P. K.; Rodemeyer, S. A. (Univ. of Notre Dame, Ind.). J. Chem. Phys., 48: 2374-6(Mar. 1, 1968).

Fluorescence decay data on ultraviolet-excited cyclohexane solutions of a number of scintillators are presented. (W.H.K.)

28111 MEASUREMENTS OF BACKGROUND RADIATION IN A ROCK SALT MINE. Kolb, W.; Lauterbach, U. (Physikalisch-Technische Bundesanstalt, Brunswick). Kerntechnik, 10: 125-30(Mar. 1968). (In German).

Background radiation measurements carried out in a North German rock salt mine are discussed. Suitable instruments are described. The dose rates measured at different rock salt deposits were found to be in the range from 0.2 to 2 μR/h, i.e., only $1/_{20}$ of the dose rate above ground. Scintillation spectrometry shows that the background radiation is due mainly to the potassium content (0.0031 to 0.29%) of the rock salt, despite this content being very low. The background counting rate of a 4" diameter × 4" high NaI(Tl) scintillation spectrometer located at the 490 m horizon in the mine was 450 counts/min in the energy range from 195 to 1930 keV without shielding, and as low as 45 counts/min with appropriate lead shielding. The advantage for the installation of a low radiation level laboratory is obvious. (auth)

28112 MEASUREMENT OF THE QUANTUM EFFICIENCY OF NOBLE-GAS SCINTILLATORS FOR X RAYS. Kiss, A. E.; Patla, N. (Sir John Cass Coll., London). J. Phys., D, 1: 617-24(May 1968).

Experimental values of the x-ray quantum efficiency of krypton, argon and neon scintillation counters for chromium, cobalt and copper K radiation were determined by comparison with a proportional counter, and the results analyzed in terms of the energy conversion efficiency of the gas atoms and statistical losses in the photomultiplier. The particular geometry and operating conditions described gave maximum efficiencies at the Cu Kα wavelength of 14% for krypton, 4.3% for argon and 3.5% for neon, falling with increase of wavelength. Application of a large electric field to the gas resulted in practical efficiencies approaching 100% due to gas amplification processes. (auth)

28113 RADIOACTIVITY IN THE ENVIRONMENT: EFFECTIVENESS AND FAILURES OF MONITORING SYSTEMS. Higinbotham, William A. (Brookhaven National Lab., Upton, N. Y.). Pediatrics, 41: Suppl., 196-206(Jan. 1968).

Various types of radiation detection devices and techniques for personnel monitoring and flux measurements are described. One is the thermoluminescent dosimeter, and another widely used personnel monitor is the pocket ionization chamber. Ionization chambers have a flat response for γ rays above 50 to 100 keV and for energetic charged particles. Recent developments in semiconductor radiation detectors are outlined. These detectors are of great interest because of the highly proportional response or energy resolution, and have largely replaced the ionization chamber for α-particle spectroscopy. Detectors with a sensitive region as thick as 1 cm are now made by compensating with Li, thus achieving a very nearly intrinsic semiconductor material. Such detectors can be used to measure the energies of electrons and protons up to several million electron volts. Another type of measurement described is the technique of coincidence γ-ray spectroscopy. How the reliability of radiation monitoring depends on various factors is outlined. (BBB)

28114 STATISTICS OF THE GENERATION OF DELAYED PULSES BY THE PHOTOELECTRIC EFFECT AS OBSERVED IN A DOUBLE COUNTER EXPERIMENT. Boucique, R. (Rijksuniversiteit, Ghent). J. Phys., D, 1: 625-9(May 1968).

When two Geiger–Müller counters are provided with cathode windows facing each other, so that photons produced in one counter can reach the other, it appears that a discharge in one counter (triggerer) is followed stochastically by a discharge in the other (follower). The position distribution function of these followers is calculated from a simple theoretical model and compared with previous experimental results. The analysis of the distribution function allows qualitative information about the structure of the individual triggering avalanches to be obtained. (auth) (UK)

28115 SYSTEM FOR ORIENTATION IN NUCLEAR RADIATION FIELDS. Kovac, J. Bela; Dantar, Karlo. Jugoslov. Pronalazastvo, 8: 1-6(Feb. 1967). (In Slovak).

A system for orientation in nuclear radiation fields is described. Two Geiger–Mueller counters respond to small differences in intensity which exist unless both detectors are in an identical position relative to the source. Differences in detected radiation intensities may be used for operating appropriate mechanisms working as direction finders for radiation sources. A nuclear radiation compass and two self-propelled source-seeking vehicles designed and built using the two-counter principle are described. (JPRS)

28116 UNIT FOR THE SIMULTANEOUS DETERMINATION OF DECAY CURVES OF SEVERAL RADIOACTIVE SAMPLES AND FOR THE MEASUREMENT OF NEUTRON FLUX DENSITY DISTRIBUTION IN NUCLEAR REACTORS. Burkart, K. (Kernforschungszentrum, Karlsruhe, Ger.); Schulz, J. Kerntechnik, 10: 131-5(Mar. 1968). (In German).

A unit is described for the parallel operation of several sample changers, the associated electronic circuitry for pulse counting, the timing control, and the data output and display units. At present the unit is used for the simultaneous observation of the radioactive decay of several samples previously activated in fast reactors in the course of spectral index and flux traverse measurements. Having determined the decay characteristics of individual samples it is possible to define and to separate interfering activities by the method of least squares. In its present application the unit is used for the measurement of relatively few samples with superposed decay characteristics, but it may also be used, without structural alteration, for the measurement of many samples with simple decay characteristics. (auth)

28117 MAXIMUM SENSITIVITY OF THE SCINTILLATION METHOD IN BETATRON DEFECTOSCOPY. Gorbunov, V. I.; Pokrovskii, A. V.; Temnik, A. K. (Tomsk Polytechnic Inst.). Defektoskopiya, No. 1, 79-82(1968). (In Russian).

A maximum energy of the betatron was analyzed and the functional relation between the size of the defect in the beam direction with the source parameters and emission detector and also parameters of examined objects was found. The minimum thickness variations recorded by the scintillation method at maximum bremsstrahlung energy of 10, 15, 20, 25, and 30 MeV and specimen (steel) thickness from 50 to 500 mm were determined. (tr-auth)

28118 UNIFORM-SENSITIVITY NEUTRON-FLUX COUNTERS BASED ON NEUTRON MODERATION. Makra, Zsigmond (Central Physical Research Inst., Budapest). Magy. Fiz. Foly., 15: 461-79(1967). (In Hungarian).

After a general review of current methods used for flux measurements on the basis of the source intensity and by energy dependent methods, the Hanson–McKibben uniform sensitivity long counter is studied, examining the distribution of thermalized neutrons, the high and low energy sensitivity, the fine structure of the sensitivity curve, the directional sensitivity, shielding problems and dose measurements. The direction-independent uniform-sensitivity BF_3 detector is of special interest for radiation protection studies. Advantages of the various types, graphite and paraffin, 4π-neutron detectors are also analyzed. The comparative sensitivities of the various BF_3-filled uniform sensitivity flux counters shown in tabular form. The practical measurement requirements are also given. (Review article, 43 references). (TTT)

28119 EFFECT OF THE SIGNAL MODULATION ON THE SEPARATING PROPERTIES OF THE PULSE-SHAPE DISCRIMINATOR. Zsolnay, Eva; Mathe, Gyorgy (Nuclear Research Inst., Debrecen, Hungary). Magy. Fiz. Foly., 15: 453-9(1967). (In Hungarian).

The pulse shape of the output of CsI(Tl) scintillators, used as a particle detector is not well defined at low energies, making it impossible to identify the individual particles below the 1-MeV level. Studies were therefore made to determine the effect of integration and simultaneous differentiation on the discrimination of the signal shape to ascertain changes in the separation of individual particles. The measurements were carried out with a radioactive preparation of Th(B + C + C'), decreasing the energy of the α particles by slowing down in air, until they were in the energy range of the γ and β particles present. Protons obtained from the collision with neutrons of a Po-Be source were used as the proton source. The results revealed that the discrimination of the CsI(Tl) crystal for particle identification is more efficient if the pulses are shaped before discrimination by a several μ second integrating circuit. The level of separation with respect to electrons and γ rays may be improved by a factor of 2. (TTT)

28120 DETECTION OF THE TRACKS OF CHARGE PARTICLES IN SOLID MATERIALS. Tuyn, J. W. N. (Reactor Centrum Nederland, Petten, Netherlands). Atoomenergie Haar Toepass., 10: 13-20(Jan. 1968). (In Dutch).

Etching methods enable the enlarging of tracks of heavy, charged, fast particles, particularly fission products, in insulators until these tracks are visible in the optical microscope. This technique is explained and its application in nuclear fission, archeology, and the production of biological filters is discussed. Activation analysis and neutron dosimetry can be performed by combining an insulator foil with a foil of fissionable material. 28 references. (J.J.t.B)

28121 PULSE-TO-ANALOG CONVERTER FOR OPTIMIZING SIGNAL-TO-NOISE FROM PHOTOMULTIPLIERS AT LOW LIGHT INTENSITIES. Akins, D. L.; Schwartz, S. E.; Moore, C. Bradley (Univ. of California, Berkeley). Rev. Sci. Instrum., 39: 715-18(May 1968).

A simple circuit is presented which is designed to discriminate and shape pulses from photomultiplier tubes and to provide an output suitable for analog recording. This circuit may readily be inserted between the photomultiplier and existing analog signal processing equipment. Signal-to-noise measurements are given for a cooled photomultiplier, with and without the pulse shaping circuitry. This circuitry affords a significant gain in the signal-to-noise ratio for a cooled phototube under conditions of low light flux when used in an analog system. The resulting signal-to-noise is governed by counting statistics alone. (auth)

28122 HIGH ENERGY γ-RAY DETECTOR WITH GOOD RESOLUTION. Dally, E. B.; Hofstadter, R. (Stanford Univ., Calif.). Rev. Sci. Instrum., 39: 658-9(May 1968). (HEPL-532).

A 12.7 × 12.7 cm cylindrical lead fluoride (PbF_2) crystal has been tested as a Cherenkov shower detector of high energy positrons. The behavior is expected to be similar for electrons and γ-rays of the same energies. The line width (full width at half-maximum) varied from 32% at 300 MeV to 16% at 900 MeV. A linear relationship between pulse height and energy was observed over the measured range. (auth)

28123 NEW WIDE BAND WINDOWLESS PHOTON DETECTOR. Grodski, J. J. (Univ. of Waterloo, Ont.); Schumacher, B. W. Rev. Sci. Instrum., 39: 702-9(May 1968).

A prototype of a new windowless photon detector has been built. Photoelectrons from a photocathode are accelerated to an energy level where they can be counted individually by means of the scintillation pulses which they produce in a scintillation counter. The geometry of the detector allows to collect not only photoelectrons from a single surface but from a number of thin foils placed behind one another, in order to increase the detection efficiency for hard x rays. Any type of cathode surface can in principle be used; tests, however were made only with a gold foil cathode. The detector has been tested at two wavelengths of about 25 and 2500 Å. Its detection efficiency can be expected to be above 1% from at least 0.5 to 1300 Å, but this has not been checked out. The only noise source in this detector against which one can not discriminate is spurious counts due to corona discharge or field emission; at 20 kV acceleration voltage this noise could be kept low enough, even at pressure levels as high as 10^{-4} torr, to count single photoelectrons. This detector scheme has the advantage that only one surface is exposed to a changing environment, namely the photocathode, and this is not particularly critical because the quantum yield for soft x-rays depends upon the volume photoelectric effect. (auth)

28124 SEMICONDUCTOR DETECTOR METHOD AND APPARATUS. Miller, G. L.; Wagner, S. E. (to United States Atomic Energy Commission). U. S. Patent 3,381,367. May 7, 1968.

A resonant charging constant power supply is described which has a capacitor for discharging constant energy pulses for reverse biasing a semiconductor for alloying lithium into the semiconductor to form a radiation detector. Vapor phase coolant means also efficiently extracts Joule heat caused by the reverse biasing. (AEC)

28125 FET PREAMPLIFIER (Engineering Materials). (California Univ., Livermore. Lawrence Radiation Lab.). (CAPE-1524).

1 drawing.

A FET preamplifier is described which is used with Ge or Si solid state detector systems. The characteristics of the preamplifier include low noise; charge sensitivity; adjustable gain; direct coupling to cold finger, vacuum system and cryogenic system; and use of dual-cooled field effect transistors. (For details see TID-4100) (F.S.)

28126 LIQUID SCINTILLATOR. (to United States Atomic Energy Commission). British Patent 1,105,929. Mar. 13, 1968. Priority date Nov. 24, 1964, United States.

An improved liquid scintillator for detecting thermal neutrons comprises a borazine compound, which acts as a combined solvent and neutron target, a primary solute dissolved in the solvent, and a secondary solute dissolved in the solvent. The borazine compound is selected from the group consisting of B-monomethylborazine, N-monomethylborazine, B,B′-dimethylborazine, B,N-dimethylborazine, N,N′-dimethylborazine, N,N′,N′′-trimethylborazine, N,B,B′-trimethylborazine, B-triethylborazine, B-tributylborazine, N-triethylborazine, and N-triisopropylborazine. The selected primary solute is 2,5-diphenyloxazole, and the selected secondary solute is dimethyl 1,4-bis-2-(phenyloxazolyl)-benzene. (B.L.M.)

28127 INDUCTIVE SPARK CHAMBER AS A DETECTOR FOR A MAGNETIC SPECTROMETER. Daniel, H.; Poelz, G.; Springer, K. (Max Planck Inst. of Nuclear Physics, Heidelberg. CERN, Geneva). Ark. Fys., 36: 163-7(1967).

From International Symposium on Why and How Should We Investigate Nuclides Far Off the Stability Line, Lysekil, Sweden. See CONF-660817.

An inductive spark chamber is described which has been built for a magnetic particle spectrometer. The spark position is determined electronically by feeding pulses induced in wire loops into a pulse-height analyzer. Both the X and Y co-ordinates can be read off. The walls of the chamber are made of a plastic film of 2.6 mg/cm^2 and metal meshes. The resolving width (full width at half-maximum) of the total system is 0.2 to 0.3 mm, and the base width 0.4 to 0.7 mm. The aspects of using spark chambers in magnetic particle-spectrometers is discussed from a more general point of view. (auth)

28128 NEW KIND OF RADIATION ANALYZER. Close, T. H.; Hirst, D. V.; Kane, J. V.; Kao, C. Y.; Kateley, J.; Shunk, W. A.; Williams, M. E. (Michigan State Univ., East Lansing). Ark. Fys., 36: 553-80(1967).

From International Symposium on Why and How Should We Investigate Nuclides Far Off the Stability Line, Lysekil, Sweden. See CONF-660817.

A computer radiation analyzer system is under construction at the Michigan State University Cyclotron Laboratory. The system is based upon the Scientific Data Systems Sigma 7 Computer which is a real-time time-sharing stored program computer. A general purpose interface will be used to aid in the transfer of information between the computer and the laboratory. This interface, which is itself a computer, has the following properties: it is designed to cover a large class of laboratory problems rather than a few special problems, it is programmable using a removable panel of cables, it is capable of performing many different and unrelated operations in parallel, it is designed to receive signals from and to send signals to a large number of different devices, and it is capable of processing both analog and digital pulses and levels. The system is intended to record data from counters, to display information on cathode-ray oscilloscopes, to establish experimental conditions and to control the cyclotron. The design permits us to do all these things simultaneously. One of the principal uses of this device will be the study of unstable nuclei, using nuclear reactions which emit more than two particles. (auth)

28129 EUROPIUM ACTIVATED STRONTIUM IODIDE SCINTILLATORS. Hofstadter, Robert (to Kewanee Oil Co.). U. S. Patent 3,373,279. Jan. 29, 1965.

The growth and preparation of europium-activated strontium iodide crystals and their use as scintillation detectors are described. (W.H.K.)

28130 WHOLE BODY SCINTILLATION DETECTOR FOR ANIMAL USE COMPRISING A PLURALITY OF PLASTIC PHOSPHOR RECTANGULAR LOGS. Keck, Charles R.; Jordan, Paul W. U. S. Patent 3,376,417. May 31, 1966.

The whole-body low-level detector system described was specifically designed to compute the lean-to-fat ratio in bodies of animals. The lean tissues contain potassium, but fat and bone contain little or none. Therefore, by measuring the potassium-40 content, the amount of lean meat can be evaluated. (W.H.K.)

28131 CURRENT MEASURING APPARATUS FOR USE WITH AN IONIZATION CHAMBER. Brown, Herbert A.; Hutson, Donald G. (to Laboratory for Electronics, Inc.). U. S. Patent 3,373,284. June 14, 1965.

An integrating circuit coupled to an ionization chamber for developing a voltage which is a function of the amplitude of the current from the ionization chamber is described. A trigger circuit is coupled to the integrating circuit to produce a pulse signal when the developed voltage reaches a predetermined threshold value. Upon the occurrence of such a pulse, reset means are provided to dissipate the voltage thereby enabling the trigger circuit to produce a train of pulses at a rate commensurate with the rate at which the voltage is developed. Finally, a pulse rate measuring circuit is used to derive an analog signal which is a logarithmic function of the pulse rate. (auth)

Nuclear Spectroscopic Instrumentation

Refer also to abstract 30040.

28132 (NIJS-R-515) SLOW NEUTRON CHOPPER TIME-OF-FLIGHT SPECTROMETER. Dimic, V.; Petkovsek, J. (Nuklearni Institut Jozef Stefan, Ljubljana (Yugoslavia)). Nov. 1967. 18p. Dep.

A description of the slow neutron chopper and time-of-flight spectrometer at the reactor Triga Mark II reactor in Ljubljana is presented. The performance of the system is also discussed. (W.H.K.)

28133 (NP-17352) PREPARACION DE FOSFOROS DE KI(Tl) PARA ESPECTROMETRIA DE RADIACION GAMMA. (Preparation of KI(Tl) Phosphors for Gamma-Ray Spectrometry). Andrade Ibarra, Eduardo (Universidad Nacional Autonoma de Mexico, Mexico City. Facultad de Ciencias). 1967. 73p. (In Spanish). Dep.

Thesis.

A detailed description is given of the operation of scintillation detectors, and the factors affecting their energy resolution are analyzed. The interaction of electromagnetic radiation with matter is discussed to establish the bases to extend the operation of scintillation detectors for γ spectrometry. The operation of activated inorganic phosphors and their efficiency dependence on the concentration of the activator are discussed. The techniques developed to machine and polish adequately KI(Tl) phosphors are described. The quality control and the techniques used are discussed. The results obtained in the comparison of the spectra of ^{137}Cs taken with the phosphor prepared and with a similar commercial phosphor are reported. (J.S.R.)

28134 (NYO-3914-1) TIME-OF-FLIGHT SPECTROMETER FOR NEUTRONS FROM 10 TO 100 MeV. Madey, Richard (Clarkson Coll. of Tech., Potsdam, N. Y. Dept. of Physics).

Oct. 24, 1967. Contract AT(30-1)-3914. 7p. (CONF-680102-5). Dep. CFSTI.

From Meeting of the American Physical Society, Chicago, Ill.

The description, operation, and resolution of a neutron time-of-flight spectrometer using scintillation detectors are presented. (W.H.K.)

28135 (NYO-3914-2) SPECTROMETER FOR NEUTRONS FROM 10 TO 100 MeV. Madey, Richard (Clarkson Coll. of Tech., Potsdam, N. Y. Dept. of Physics). Jan. 15, 1968. Contract AT(30-1)-3914. 26p. (CONF-680302-5). Dep. CFSTI.

From International Symposium on Nuclear Electronics and Radioprotection, Toulouse, France.

A new radiation detector instrument system has been designed to measure the spectra of neutrons in the energy region from about 10 to 100 MeV. The principle of the energetic-neutron spectrometer requires first that the incident neutron lose a small fraction of its energy in a collision with a proton in an hydrogenous scintillator and then that the scattered neutron interacts in another scintillator spaced a suitable distance from the first scintillator. The time interval between the two scintillation pulses provides a measure of the neutron energy. Means for discriminating against background events include an anti-coincidence arrangement for rejecting charged particles and a pulse-shape discrimination scheme for rejecting neutron interactions with carbon nuclei. Gamma rays are rejected by time-of-flight and also by pulse-shape discrimination circuitry. (auth)

28136 SEMICONDUCTOR SPECTROMETERS. Ewan, G. T. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Prog. Nucl. Tech. Instrum., 3: 67-157(1968).

The present status of semiconductor detector development and the use of semiconductor detectors in nuclear physics experiments are presented. Topics discussed include properties of semiconductors, principles of operation, factors affecting energy resolution, heavy charged-particle spectroscopy, gamma spectroscopy, and beta spectroscopy. (auth)

28137 PARTICLE TRAJECTORIES IN MAGNETIC FIELDS. A COMPARISON BETWEEN CALCULATED AND EXPERIMENTAL RESULTS. Besev, C.; Groth, T.; Kleinheinz, P.; Olsen, B.; Pettersson, G.; Schneider, W. (Univ., Uppsala). Nucl. Instrum. Methods, 62: 147-65(June 15, 1968).

The significance of specific numerical methods for calculation of particle trajectories in magnetic fields are demonstrated by comparing calculated focusing properties with corresponding experimentally established ones. The comparison is made for the focusing features of an electron spectrometer, and the calculations are based upon the magnetic field as obtained by a direct measurement in this spectrometer. Calculated and measured results are in very good agreement. A general approach to the application of computer techniques to the design of focusing magnets is discussed. (auth)

28138 COMPUTER INVESTIGATIONS OF A DOUBLE FOCUSING SPECTROMETER AND COMPARISONS WITH EXPERIMENTAL RESULTS. Besev, C.; Castman, B.; Nordberg, R.; Olsen, B.; Pettersson, G. (Univ., Uppsala). Nucl. Instrum. Methods, 62: 125-46(June 15, 1968).

A new approach is used for investigating the optical properties of magnetic fields in ironfree particle focusing devices. It has been applied to a double focusing current sheet spectrometer. The magnetic field over a grid is directly computed from the coils. Accurate numerical integration techniques have been successfully applied for the calculation of the focusing properties of the instrument. The calculations agree with the experimental results within the accuracy of the measurements. This type of calculation is therefore of great value in the design and optimization of ironfree focusing instruments. (auth)

28139 GAMMA SPECTROMETRY BY CADMIUM TELLURIDE (CdTe) n-p COUNTERS (SOLID STATE). Arkad'eva, E. N.; Maslova, L. V.; Matveev, O. A.; Ryvkin, S. M.; Rud', Yu. V. (Ioffe Inst. of Physics and Tech., Leningrad). Fiz. Tekh. Poluprov., 2: 279-80(1968). (In Russian).

Surface barrier n-p transitions were created on n-type CdTe having an electron concentration of 3×10^{14} cm^{-3} and a mobility of 500 cm^2/v.sec. The initial CdTe had been purified by zone melting. The working voltage was ~50 v with a thickness of the sensitive region of ~30 μ. The narrow working region of the detector was due to the appearance of a significant number of pulses from Compton electrons which were superimposed on the photopeak, and distorted the energy spectrum. Nevertheless the detector resolution was ~4.5 kev after subtracting the noise of the detector and equipment. The internal detector noise did not exceed 6 keV. The resolution was ~3.5% for gamma quanta of ^{57}Co at room temperature. (TTT)

28140 TRIPLE-AXIS SPECTROMETER FOR NEUTRON INELASTIC SCATTERING. Chumbley, L. (Atomic Energy Research Establishment, Harwell, Eng.); Dyer, R. F.; Wallis, D. E. J. Phys. E, 1: 528- (May 1968).

A description is given of a triple-axis spectrometer for use at the Pluto reactor at AERE, Harwell. The specification of the instrument is outlined, together with a discussion of the problems arising therefrom and the novel methods adopted to overcome them, including the use of gas pads to support the detector shield and a small data processor for instrument control. (auth) (UK)

28141 REDUCING PULSE HEIGHT SPECTRAL DISTORTION BY MEANS OF DC RESTORATION AND PILE-UP REJECTION. Williams, C. W. (ORTEC, Inc., Oak Ridge, Tenn.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: 297-302(Feb. 1968).

From 14th Nuclear Science Symposium, Los Angeles. See CONF-671026.

A method of assembly, from standard laboratory equipment, of a monoenergetic, random time-interval, pulse generator with variable pulse height and count rate for the study of count rate spectral distortion in nuclear electronics is presented. The necessary equipment consists of a noise source, a discriminator, a time-to-pulse-height converter (non-shaping type), and a section of coaxial cable for delay. With the aid of the pulse generator, methods of dc restoration were explored. A dc restorer was designed, and is presented, which reduces spectral distortion by an order-of-magnitude from comparable previously published methods. When the dc restoration is performed on a spectrum of unipolar pulses from a capacity coupled system, positive-on-negative distortion, which appears as left side or low energy tailing (and is by far the most detrimental since long time constants are involved) is reduced; however, positive-on-positive, which creates the sum spectra, is not affected. The additional function of pile-up rejection has been used to further reduce both effects. It is demonstrated that a combination of dc restoration and pile-up rejection yields a high-resolution pulse height spectrum which is undistorted for at least three decades at count rates greater than 50 kHz. (B.G.D.)

28142 REMOTE PULSE-HEIGHT ANALYZER AND TELEMETRY LINK. Keathley, J. A. (Oak Ridge National Lab., Tenn.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: 362-5(Feb. 1968). (ORNL-P-3464).

From 14th Nuclear Science Symposium, Los Angeles. See CONF-671026.

A system was needed for transmitting gamma-ray pulse-height information from high altitude to earth. In the system designed, a pulse-height analyzer accepts pulses from gamma-ray detectors, determines their amplitude, and transmits this information in serial form on an event-by event basis via telemetry to a ground station where it is stored on magnetic tape and in the memory of a modified multichannel analyzer. This provides a real-time visual observation of the data as it is accumulated, in addition to facilitating preflight calibration. The on-board analyzer was successfully flown at an altitude of 20 miles for 4 hours, and the telemetry translator was used to decode the magnetic tape recordings. (auth)

28143 A 90^0 ^{3}He NEUTRON SPECTROMETER. Brown, W. K.; Ellis, A. N.; Peterson, D. D. (Los Alamos Scientific Lab., N. Mex.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: 404-10(Feb. 1968).

From 14th Nuclear Science Symposium, Los Angeles. See CONF-671026.

A fast ^{3}He neutron spectrometer has been developed that is free of recoil spectrum effects. Positioning solid-state detectors outside the neutron beam at 90° results in this advantage and avoids nuclear reactions in the detectors themselves. Two modes of operation are examined: In conjunction with a pulse height analyzer, and in a high-event-rate, current-signal regime. The spectrometer was used in the latter mode to measure the neutron spectrum produced by a nuclear explosive in the Los Alamos time-of-flight neutron cross-section measurements. (auth)

28144 DESIGN OF BUFFER MEMORIES FOR MULTI-CHANNEL NEUTRON TIME-OF-FLIGHT ANALYSIS. Hahn, Jack (Columbia Univ., New York). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: 157-62(Feb. 1968).

From 14th Nuclear Science Symposium, Los Angeles. See CONF-671026.

The logical, or system, organization of a buffered data storage system designed expressly for non-stationary randomly arriving data is described. The system makes use of multiple levels of buffering. Simulation on a digital computer is used as a design technique. The system was evaluated for an input arrival distribution expected from Columbia University's Nevis Neutron Ve-

locity Spectrometer. It was shown that the amount of high speed memory required can be reduced by factors of 100, or more, when compared with more conventional single level buffer storage systems. (auth)

28145 TRUE GAMMA-RADIATION SPECTROMETER. Young, Myron H. (Louisiana State Univ., Baton Rouge); Burrus, Walter R. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: 142-4(Feb. 1968).

From 14th Nuclear Science Symposium, Los Angeles. See CONF-671026.

A true gamma-radiation spectrometer is described which utilizes a standard 3- by 3-in. dia NaI(Tl) scintillation detector and outputs the gamma spectrum (in photons MeV^{-1} cm^{-2} sec^{-1}) with all spurious peaks and tails corrected. A small digital computer is utilized to accumulate the pulse-height distribution and simultaneously perform a digital filtering operation in real time. (auth)

28146 UNIQUE ROCKET-BORNE DATA HANDLING SYSTEM FOR SOLAR X-RAY STUDIES. Reed, R. D.; Bakke, J. C.; Reagan, J. B.; Acton, L. W. (Lockheed Missiles and Space Co., Palo Alto, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: 252-7(Feb. 1968).

From 14th Nuclear Science Symposium, Los Angeles. See CONF-671026.

The design of a high-speed, high-resolution spectrometer system for detection and analysis of low-energy x rays from a spinning rocket is described. The system was comprised of four large-area beryllium-window proportional counters, an analog pulse-height-to-time converter, a digital data assembler and a complete PCM multiplexer. (B.G.D.)

28147 DETECTOR PULSE SHAPING FOR HIGH-RESOLUTION SPECTROSCOPY. Konrad, M. (Columbia Univ., New York). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: 268-82(Feb. 1968).

From 14th Nuclear Science Symposium, Los Angeles. See CONF-671026.

Shaping is considered with respect to minimizing the random errors with respect to detector pulse measurements. Some properties of time variant and invariant linear networks are considered. It is shown that the weighting function characterizes both time variant and invariant networks with respect to the determination of the errors. The errors are classified according to their origin and character. Errors due to noise, pile up and base line shift are considered. Equations for their variances and average values are derived using the weighting function and the statistical properties of random impulses. The weighting function characteristics, such as shape and time scale, are considered with respect to the resulting errors. The characteristic of the weighting function, required to minimize or decrease particular errors are discussed. Particular attention has been given to base line error reduction. (auth)

28148 HIGH RESOLUTION GAMMA-RAY SPECTROSCOPY WITH LITHIUM ION DRIFTED GERMANIUM DETECTORS. PART II. APPLICATION TO NUCLEAR PHYSICS. Chung, Moon-kyu (Atomic Energy Research Inst., Seoul). J. Nucl. Sci. (Seoul), 7: 12-28(1967).

Planar-type LID Ge diodes were applied to the gamma-ray measurements of short lived nuclei with half-life less than a few minutes, which include decays of $^{182m,185m}W$, $^{108,110}Ag$, $^{75m,77m}Ge$, ^{71}Zn, ^{161}Gd, and ^{46m}Sc. After determination of detection efficiency for a LID Ge diode with 1 mm depletion depth, gamma rays from $^{152,154}Eu$ decays were re-examined; intensities are given. For routine determination of uranium isotopic contents, gamma-ray spectrum from ^{235}U was taken and the results are shown. The experimental facilities for studying gamma-rays from thermal neutron capture in ^{149}Sm and the results of the measurements are presented. Also, pair and Compton spectrometers employing LID Ge diodes are discussed. The energy resolution was improved with a pair spectrometer from 30 keV FWHM to 19 keV FWHM at the double escape peak of ^{24}Na 2754-keV gamma rays. (auth)

28149 SATELLITE INSTRUMENTATION FOR CHARGED PARTICLE MEASUREMENTS. II. MAGNETIC ANALYZER FOR 0.1 TO 1.0 MeV ELECTRONS. Paolini, F. R.; Theodoridis, G. D.; Welsh, W. F. (American Science and Engineering, Cambridge, Mass.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: 194-9(Feb. 1968).

From 14th Nuclear Science Symposium, Los Angeles. See CONF-671026.

A 180°-focussing magnetic analyzer for OV1-13 is described. It has an array of eight solid-state detectors in the focal plane and uses upper level discrimination to reject analysis of penetrating protons. Fields of view vary from 16° × 9° (Channel 1) to 4° × 9° (Channel 8), and energy bin-widths from 26% to 13%, Channel 2 to 8. A similar instrument is giving good data from OV1-9. (auth)

28150 SATELLITE INSTRUMENTATION FOR CHARGED PARTICLE MEASUREMENTS. IV. SOLID STATE SPECTROMETERS FOR 0.1 TO 1.0 AND 0.8 TO 6.0 MeV PROTONS. Paolini, F. R.; Theodoridis, G. C.; Welsh, W. F. (American Science and Engineering, Cambridge, Mass.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: 205-9(Feb. 1968).

From 14th Nuclear Science Symposium, Los Angeles. See CONF-671026.

Solid-state proton spectrometers for OV1-13 are described. Pulses from totally-depleted transmission detectors are accepted for differential analysis only if unaccompanied by pulses in a back-up detector. Geometrical factors are 0.5×10^{-2} cm^2 ster and 1.0×10^{-2} cm^2-ster respectively for the lower and higher range instruments; energy bin-widths are approximately 20%. Similar instruments are giving good data from OV1-9. (auth)

28151 SATELLITE INSTRUMENTATION FOR CHARGED PARTICLE MEASUREMENTS. V. RANGE-ENERGY SPECTROMETER FOR 6 TO 100 MeV PROTONS. Paolini, F. R.; Theodoridis, G. C.; Welsh, W. F. (American Science and Engineering, Cambridge, Mass.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: 210-13(Feb. 1968).

From 14th Nuclear Science Symposium, Los Angeles. See CONF-671026.

A range-energy proton spectrometer for OV1-13 is described. It uses a stack of solid-state detectors and absorbers plus a dE/dx detector. Logic identifies the last detector in sequence to record a signal, but only if the dE/dx signal is appropriate. The geometrical factor is 1.0×10^{-2} cm^2-ster; energy bin-widths are approximately 35%. (auth)

28152 HIGH-RESOLUTION GAMMA-RAY SPECTROMETER FOR USE IN OUTER SPACE. Marshall III, J. Howard (Analog Technology Corp., Pasadena, Calif.); Halpern, Edward. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: 242-51(Feb. 1968).

From 14th Nuclear Science Symposium, Los Angeles. See CONF-671026.

A pulse-height analysis system for a large-area, high-resolution gamma-ray spectrometer using lithium-drifted germanium detectors is described. This analyzer, which can operate untended with a high-degree of precision over a large temperature range, possesses sufficiently compact construction and low power consumption to be suitable for use in balloon or satellite experiments. Design techniques and performance data are presented. (auth)

28153 BENT CRYSTAL SPECTROMETER FOR USE WITH A GERMANIUM DETECTOR. Jewell, R. W.; John, W.; Massey, R.; Saunders, B. G. (Univ. of California, Livermore). Nucl. Instrum. Methods, 62: 68-76(June 1, 1968). (UCRL-70864).

A bent crystal spectrometer has been constructed in the Cauchois geometry for use with a Ge detector. The design is mechanically simple and capable of high accuracy. In the usual slit scanning mode of operation, the Ge detector improves the signal-to-background ratio. Another mode is described utilizing the bent crystal to preselect an energy band for analysis by the Ge detector, thus suppressing Compton interference. A new measurement has been made of the 59 keV gamma ray from ^{241}Am with the result: $E_\gamma = 59.536 \pm 0.001$ keV. (auth)

28154 PORTABLE TRANSPORTABLE GAMMA SPECTROMETER. Varvarin, G. B.; Rusyaev, V. G. Geol. Geofiz., Akad. Nauk SSSR, Sib. Otd., 123-9(1966). (In Russian).

A portable gamma spectrometer has been developed at the Nuclear Geophysics Laboratory of the Institute of Geology and Geophysics of the Siberian Branch of the Academy of Sciences of the USSR to meet the following requirements: It should be as all-purpose as possible and operate both with scintillation detectors and gas-discharge counters; it should satisfy all requirements for portable field apparatus; it should be a single-channel analyzer with several levels of discrimination and at the same time provide for the possibility of operating as an integral discriminator; and as high accuracy of counting of output pulses is required, it should have an electromagnetic counter of standard type at the output. (Geophys. Abstr.)

28155 A DIGITAL FILTER FOR UNFOLDING PULSE-HEIGHT DISTRIBUTIONS. Young, M. H. (Louisiana State Univ., Baton Rouge); Burrus, W. R. Nucl. Instrum. Methods, 62: 82-92 (June 1, 1968). (ORNL-P-3448).

A computer program has been developed which acts as a digital filter to remove undesired spurious features (such as Compton tails, escape peaks, etc.) from the response of a scintillation spectrometer. The input to the filter is the digital representation of the pulse-height distribution, and the output consists of a digital

representation of the desired unfolded spectrum. A relatively clean Gaussian line is obtained from the filter. The filtering procedure is simple enough that small computers have been used on-line (or built-in circuitry can be used) to give rapid unscrambled results. Thus far we have demonstrated the capabilities of the filter up to 4 MeV both with a 3″ × 3″ NaI(Tl) gamma spectrometer (using data of Heath) and with an 8″ × 12″ NaI(Tl) total absorption gamma spectrometer. The program written in FORTRAN-4 language includes nonlinearity corrections and rigorous error estimates. The filter has been extensively simulated on off-line computers (IBM 7090 and CDC 1604) and we have a simplified working version for the PDP-8. The execution time for 128 channels for the IBM 7090 version is about 1 sec, and for the PDP-8 version is about 6 sec. (auth)

28156 STATISTICAL ANALYSIS OF A SCINTILLATION SPECTROMETER. Gatti, Emilio (Politecnico, Milan). Rend. Semin. Mat. Fis. Milano, 37: 220-35(1967). (In Italian).

A statistical model of the scintillation spectrometer is developed. The results are used in order to evaluate the timing inaccuracies in nuclear events detection due to the statistics of physical processes involved. (auth)

28157 HIGH-SENSITIVITY CONTINUOUS PLUTONIUM AIR MONITOR. Tanaka, E.; Iwadate, S.; Miwa, H. (National Inst. of Radiological Sciences, Chiba, Japan). Health Phys., 14: 473-82(May 1968).

A ^{239}Pu air monitor based on the combined principle of alpha spectrometry and beta-alpha delayed coincidence was developed. Air is sampled on a fixed filter paper (Millipore AA) and its alpha and beta activities are continuously monitored with a CsI(Tl) scintillator 50 mm in dia. by 2 mm thick. Alpha pulses are discriminated against beta pulses by means of the pulse-shape discrimination technique, and alpha pulses due to ^{239}Pu are further selected by pulse-height analysis. The contribution of radon daughters to the Pu-channel is compensated by subtracting a constant ratio of the beta-alpha coincidence rate due to RaC – RaC′, and the contribution of thoron daughters is cancelled by subtracting a constant fraction of the count rate of high-energy alpha particles from ThC′. It was possible to operate the monitor with a threshold of integrated dose of 8 MPC/hr in an atmosphere of unfiltered air. By ventilating the laboratory through a glass fibre filter, the sensitivity was improved to 2MPC/hr. Factors affecting zero-stability of the monitor are discussed theoretically, and the proposed method was proved superior to the conventional methods. (auth) (UK)

28158 PARALLEL-PLATE PHOTOELECTRON SPECTROMETER. Eland, J. D. H.; Danby, C. J. (Oxford Univ.). J. Phys. E, 1: 406-8(Apr. 1968).

A simple photoelectron spectrometer employing a parallel-plate electrostatic energy analyser is described. Preliminary results showing good sensitivity down to a resolution of 25 mV are presented. (auth)

28159 NEUTRON SPECTROMETER USING PULSE SHAPE DISCRIMINATION. Jones, D. W. (Univ. of Virginia, Charlottesville). Nucl. Instrum. Methods, 62: 19-28(June 1, 1968).

A system for discriminating between scintillation pulses induced in a stilbene crystal by neutrons and gamma rays particularly from photo nuclear reactions is described. The pulse shape discriminator operates on a single voltage pulse from a scintillation counter and provides well-separated output pulses of opposite polarity to identify neutrons and gammas. The discriminator may be easily and quickly balanced to obtain discrimination with the aid of a test pulser incorporated in the system, and it is possible to reduce the dead time of the discriminator to less than 1 μsec. This system has been used in a neutron spectrometer to investigate the energy spectrum of neutrons in the energy range from 1 to 15 MeV. (auth)

28160 OPTICAL PROPERTIES OF ELECTRONIC REFRACTING SYSTEMS. Kel'man, V. M.; Yakushev, E. M. (Inst. of Nuclear Physics, Alma-Ata, USSR). Zh. Tekh. Fiz., 37: 2121-36(Dec. 1967). (In Russian).

The electron optics of the two-dimensional deflecting fields of particle spectrometers in which collimation and focusing are achieved with the aid of axially symmetric lenses are discussed. The discussed two-dimensional deflecting fields are those for which both the scalar and vector potentials depend only on the coordinates y and z of a Cartesian coordinate system x, y, z, and only the x component of the vector potential differs from zero. Such a two-dimensional deflecting field is called a "refracting" field if the inclination to the x axis of the trajectory in the field-free image space differs from the inclination to the x axis of the same trajectory in the object space. In the entire discussion it is assumed that the axially symmetric focusing and collimating lenses are aberration free. It is shown that there are two related families of curves (called aberrationless curves), one family in the object plane and one in the image plane, such that a point on one of the aberrationless curves in the object plane is imaged as a segment of the corresponding curve in the image plane. By properly disposing the source and exit slit with respect to these aberrationless curves one can produce a spectrometer whose resolving power is not affected by the aberrations of the two-dimensional field. Two-dimensional refracting fields are therefore very suitable for use as deflecting elements in high resolution spectrometers. (ATD)

28161 THREE AXIS CRYSTAL SPECTROMETER FOR NEUTRONS. Stedman, R.; Nilsson, G. (Aktiebolaget Atomenergie, Studsvik, Sweden). Rev. Sci. Instrum., 39: 637-45(May 1968).

The spectrometer described has been in operation since 1963 at the reactor R2 in Studsvik, mainly for measurements on phonons in metals, with emphasis on precision. Shielding is considered first, with mention of conclusions drawn from experimentation with the shielding around the beam from the reactor and with that around the detector. The mechanical design aims to achieve easy exchange or replacement of parts (particularly crystals and collimators), automatic operation, and low cost. Angles are changed and measured by means of worm gears driven by further gears from stepping motors, which permits control of the spectrometer from a programming tape in a simple and reliable manner. Some examples are given of results for aluminum. (auth)

28162 THE ROTATING CRYSTAL SPECTROMETER AT ISPRA. Meister, H.; Haas, R.; May, F.; Schenk, Ch.; Weckermann, B. (Gemeinsames Forschungszentrum, Ispra, Italy). Kerntechnik, 10: 145-55(Mar. 1968). (In German).

The rotating crystal spectrometer at the Ispra 1 reactor is a rotating crystal with phase-stabilized chopper. The construction of this instrument is described. The characteristics of the spectrometer and methods for their calculation and measurement are discussed. (auth)

28163 NEUTRON ACTIVATION SPECTROMETRY SYSTEM. Frank, Donald H. (to Nuclear-Chicago Corp.). U. S. Patent 3,376,420. Aug. 10, 1964.

A neutron generator and scintillation gamma spectrometer system with voltage discriminator and multichannel pulse-height analyzer are described for neutron activation analysis. (W.H.K.)

28164 ROUTINE COMPUTER USE IN NUCLEAR SPECTROSCOPIC DATA HANDLING. Eskola, Kari; Paatero, Pentti (Univ. of Helsinki). Ark. Fys., 36: 581-4(1967).

From International Symposium on Why and How Should We Investigate Nuclides Far Off the Stability Line, Lysekil, Sweden. See CONF-660817.

A computer program, designed for general data handling tasks in nuclear spectroscopy, is described. The program is written in ALGOL 60 for Elliott 503, but it also includes minor parts in machine code. A special feature of the program is that the user is not required to have any previous experience in programming. (auth)

High Energy Physics Instrumentation

Refer also to abstract 29620.

28165 (SLAC-82) HUMMINGBIRD FILM DIGITIZER SYSTEM. van der Lans, J.; Pellegrin, J.-L.; Slettenhaar, H. J. (Stanford Linear Accelerator Center, Calif.). Mar. 1968. Contract AT(04-3)-515. 57p. Dep. CFSTI.

The Hummingbird automatic film digitizer for analyzing particle tracks on bubble and spark chamber film is described. Also, precision cathode ray tube deflection systems for graphical data processing are discussed. Tube geometry and deflection distortions, deflection amplifiers, focus corrections, spot size and pulse detection, and filtering and track center circuits are considered. (W.H.K.)

28166 SPARKOSTRICTIVE SPARK CHAMBERS WITH PIEZOELECTRIC READOUT. Grove, R.; Kaufman, L.; Perez-Mendez, V. (Univ. of California, Berkeley). Nucl. Instrum. Methods, 62: 105-8(June 1, 1968). (UCRL-18003).

The construction, operation and characteristics of a spark chamber with a digital readout of coordinates that is unaffected by magnetic fields are described. (auth)

28167 WIRE SPARK CHAMBER READOUT USING CAPACITORS AND FIELD EFFECT TRANSISTORS. Neumann, M.; Nunamaker, T. A. (Univ. of Chicago). Nucl. Instrum. Methods, 62: 121(June 1, 1968).

A wire spark chamber readout that is insensitive to magnetic fields, and capable of detecting very weak discharges is described.

A capacitor in series with each wire of the spark chamber serves as the memory element. This memory is readout by discharging it with a field effect transistor into a data bus. Operation of an experimental chamber is described. (auth)

28168 BUBBLE CHAMBER PROGRESS AT THE ARGONNE NATIONAL LABORATORY. Engineer, 225: 571-2(Apr. 5, 1968).

The 12 ft H_2 bubble chamber for the Zero Gradient Synchrotron is briefly described. A superconducting magnet is used to produce a uniform field of 18 kG in the chamber. Aspects of bubble chamber technology discussed include optical problems and the use of heavy liquid chambers. (UK)

28169 ELECTRONIC ASSEMBLY FOR AUTOMATIC COUNTING OF GRAINS IN NUCLEAR EMULSIONS. Bernheim, A.; Combes, M.; Fayolle, J. C.; de Surville, H.; Morand, M. (Faculte des Sciences, Paris). Rev. Phys. Appl., Suppl. J. Phys., 3: 59-60(May 1968). (In French).

A device is described which, starting from a closed circuit television chain, provides automatic blob counting of tracks in nuclear emulsions. (auth)

28170 ANGULAR REFLECTIVITY OF SCOTCHLITE IN LIQUID HYDROGEN. Barney, H.; St. Lorant, S. J. (Stanford Univ., Calif.). Rev. Sci. Instrum., 39: 782-3(May 1968). (SLAC-PUB-363).

Scotchlite was tested for use as a bright field retrodirective illuminator in hydrogen bubble chambers. Angular reflectivity data both in hydrogen and in dry air at atmospheric pressure are presented. It is concluded that the Scotchlite tested is not suitable for bright field illumination use in hydrogen bubble chambers. (W.H.K.)

28171 MANUFACTURE OF A PHOTOGRAPHIC NEGATIVE WITH PARALLEL LINES FOR SPARK CHAMBERS. Rust, David R. (Argonne National Lab., Ill.). Rev. Sci. Instrum., 39: 769-70(May 1968).

A process is described for preparing a photographic master for etching evenly spaced lines in a metal–Mylar laminate to be used in digitized spark chambers. (W.H.K.)

28172 DEVICE FOR TRIGGERING A NUCLEAR PARTICLE DETECTOR OF THE GAS TYPE. Lansiart, Alain; Leloup, Jean; Lequais, Jean (to Commissariat a l'Energie Atomique). U. S. Patent 3,373,283. June 3, 1964. Priority date June 11, 1963, France.

A high-voltage trigger for a spark chamber is described. Incident ionizing particles are detected by the anode which triggers a high-voltage pulse to the cathode of a spark chamber which records the path of the particle. A block diagram is included. (W.H.K.)

28173 FULLY STABILIZED SUPERCONDUCTING STRIP FOR THE ARGONNE AND BROOKHAVEN BUBBLE CHAMBERS. Wong, J.; Fairbanks, D. F.; Randall, R. N.; Larson, W. L. (Norton Co., Natick, Mass.). J. Appl. Phys., 39: 2518-23(May 1968).

From Applied Superconductivity Conference and Exhibition, Austin, Tex. See CONF-671116.

Composite strip conductors for the two largest superconducting magnets yet to be built are described. The conductors consist of six bands of Nb–48% Ti alloy buried in 2-in.-wide strips of copper. The conductors for the two magnets have, respectively, critical current capacities of 3000 and 5880 A. In addition, the quality of the bond between copper and superconductor is excellent, and the copper conductivity is high. Data are presented for these and other characteristics of the strip as manufactured. The strip conductors are anisotropic in their critical-current behavior with respect to field orientation. The importance of this fact in designing magnets economically is pointed out. Performance results are given for a 24-in. i.d. test coil containing a ton of strip. Many strip configurations are possible and can be easily produced. Costs of strip of this type will be competitive with present materials. (auth)

Radiation Dosimeters

Refer also to abstracts 28113 and 28480.

28174 (AERE-R-5131) IMPROVED SPHERICAL DOSE EQUIVALENT NEUTRON DETECTOR. Leake, J. W. (Atomic Energy Research Establishment, Harwell (England)). Feb. 1968. 8p. Dep. CFSTI. UK.

Improvements have been made to the spherical neutron detector developed earlier. The scintillation detector used in the earlier spherical moderator assembly has been replaced by a small spherical proportional counter, filled with ^{3}He gas, and this improves the gamma rejection properties, particularly at the higher gamma energies (E_γ > 3.5 MeV) where the earlier detector was particularly sensitive. The new detector has a neutron/gamma ratio better than 1000/1 for a range of gamma energies from 0 to at least 7 MeV. The neutron sensitivity and the neutron energy response of the complete detector assembly have also been improved so that with a calibration figure of 8 cps = 2.5 mrem/h the detector matches the ICRP (1963) recommendations within a factor of 2 (+100% – 50%) from 0.025 eV to 7 MeV. The total weight is unchanged at 5 kg (11 lbs). The new detector is used in the Harwell monitor 0075 which has a total weight of 6.6 kg (including batteries). (auth)

28175 (AERE-R-5656) PROPORTIONAL COUNTER FOR PERSONNEL NEUTRON DOSIMETRY. Yoshida, Y.; Dennis, J. A. (Atomic Energy Research Establishment, Harwell (England)). Mar. 1968. 21p. Dep. CFSTI. UK.

A proportional counter has been developed as a solution to the specific problem of measuring the dose equivalent to personnel from neutrons with energies greater than 10 keV. The dimensions of the prototype counter are 12 × 3 × 1 cm. It consists of three cells with conductive plastic walls with atomic composition equivalent to tissue and filled with hydrogenous gas. The sensitivity to fast neutrons of the prototype counter is 60 ± 12 counts/mrem over the energy range of 20 keV to 17 MeV with an estimated threshold neutron energy less than 10 keV and a sensitivity to thermal neutrons of about 30 counts/mrem. The discrimination against ^{60}Co gamma is better than 2% (i.e., a sensitivity of less than 1.2 counts/mrem of gamma radiation). When the counter is in contact with a human body, the sensitivity to thermal neutrons is increased to 50 counts/mrem and the sensitivity to a 1/E spectrum of neutrons up to 10 keV becomes about 20 counts/mrem in comparison to the increased fast neutron sensitivity of 70 counts/mrem. These values differ from the free air values because of the effects of neutron reflection from the body. (auth)

28176 (BNWL-SA-1760) ENDOTHERMIC PROCESSES IN TISSUE-EQUIVALENT PLASTIC. Fleming, D. M.; Glass, W. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Apr. 4, 1968. Contract AT(45-1)-1830. 10p. (CONF-680421-1). Dep. CFSTI.

From 16th Annual Radiation Research Society Meeting, Houston, Tex.

An experimental evaluation of the thermal defects due to endothermic chemical reactions encountered in using tissue-equivalent plastic in absorbed dose calorimeters is presented. Absolute calorimetric measurements were made using Shonka-type tissue-equivalent plastic irradiated with monoenergetic protons. (W.H.K.)

28177 (FFN-74) ON THE USE OF NIOBIUM AS A NEUTRON DOSE MONITOR. Hellstroem, S. (Aktiebolaget Atomenergi, Studsvik (Sweden)). Nov. 1967. 25p. (CONF-650676-3). Dep.

From Conference of the Swedish National Committee for Physics, Uppsala, Sweden.

Irradiation of samples of ^{93}Nb-foils together with neutron flux indicators has been done in reactor positions with different epithermal to thermal neutron flux ratios. Two samples were covered with a 1 mm thick Cd-layer. The activities from the isotopes formed: ^{94}Nb, ^{95}Nb, and ^{92}Nb were measured with a Ge(Li)-detector after purification of the samples from ^{182}Ta. The half-lives of the isotopes were re-determined: $T_{\frac{1}{2}}(^{94}Nb) = (2.35 \pm 0.16) \cdot 10^4$ years: $T_{\frac{1}{2}}(^{95}Nb) = 34.7 \pm 0.4$ days and $T_{\frac{1}{2}}(^{92}Nb) = 10.00 \pm 0.06$ days. The activation function of ^{94}Nb was calculated from the measured data as well as its cross sections for thermal and epithermal neutrons. (auth)

28178 (NP-17349) DOSIMETRO PARA NEUTRONES CON ESFERAS DE POLIETILENO. (Polyethylene Sphere Neutron Dosimeter). Jimenez Garcia, Felip Ignacio (Universidad Nacional Autonoma de Mexico, Mexico City. Facultad de Ciencias). 1967. 59p. (In Spanish). Dep.

Thesis.

The basic concepts of the interaction of neutrons with matter and the principles of neutron detectors are summarized. The characteristics of ^{6}LiI(Eu) as a neutron detector are discussed. Also, the design and construction of a neutron dosimeter with a ^{6}LiI(Eu) crystal as the detector is described. The operational characteristics of the dosimeter were determined, and the results are reported. (J.S.R.)

28179 HIGH RESOLUTION GAMMA-RAY SPECTROSCOPY WITH LITHIUM ION DRIFTED GERMANIUM DETECTORS. PART I. DETECTOR FABRICATION AND PERFORMANCES. Chung, Moon Kyu (Atomic Energy Research Inst., Seoul). J. Nucl. Sci. (Seoul), 7: 1-11(1967).

After a brief introduction to the lithium ion drift method, de-

tailed fabrication procedures for planar lithium-drifted Ge detectors are given. Among the methods tested for ohmic contacts to the diodes, Hg–In amalgam seems to be excellent and the easiest way for this purpose. And also it is observed that the two types of structural change, p-n-i-p and p-i-n, from original n-i-p structure of the diode can occur due to the effects of long term temperature cycling from liquid nitrogen to the ambient temperatures and discussions are made on the responsible factors for extending diode life. (auth)

28180 HETEROPOLYACIDS FOR HIGH LEVEL DOSIMETRY. Flannagan, Gordon N. (E. I. Du Pont de Nemours and Co., Parlin, N. J.). Photogr. Sci. Eng., 12: 117-18(Mar.-Apr. 1968).

The phospho- and silico-heteropolyacids of Mo and W in organic binders turn blue monotonically during exposure to high doses of electrons or x rays. The sensitivity is sufficient to provide, in film form, systems suitable for the quantitative measurement of radiation levels. Although the blue from W compounds is not stable, the Mo compounds provide stable images in different organic binders. The coloration results from reduction of Mo(VI) to Mo(V) by the binder to form molybdenum blue. Molybdenum blue consists of a mixture of the oxides of Mo(VI) and Mo(V); the precise chemical constituency is now known. Quantitative data are reported for thin films of phosphomolybdic acid in polyvinyl alcohol. A mechanism is proposed to explain the experimental data, and rate constants are reported for formation and destruction of molybdenum blue. (BBB)

28181 HIGH-ALTITUDE RADIOLOGICAL INSTRUMENTATION SYSTEM. Jensen, P. K. (Solid State Radiations, Inc., Los Angeles); Katzenstein, H. S.; Zatzick, M. R.; Conklin, J. C. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: 383-98(Feb. 1968).

From 14th Nuclear Science Symposium, Los Angeles. See CONF-671026.

An aircraft dosimetry system containing a permanently sealed-off linear energy transfer (LET) spectrometer, tissue equivalent ionization chamber (TEIC) and Geiger-Mueller counter (GMC), was designed, fabricated, and partially evaluated. The integrating TEIC covers the dose rate range 0.2 mrads/h to 5 rads/h, the LET counter covers the range 0.2–100 keV/μ, and the GMC operates up to 10^4 counts/sec. Data are presented in 13 channels, binary coded at 18 bits per channel, and stored in digital form on magnetic tape with a storage capability equal to a five-hour flight mission. The tape cartridge is removable for subsequent data reduction accomplished by conversion to standard IBM format by ground-based tape-to-tape converter. Dose and Quality Factor measurements were made for x-rays, gamma-rays, protons, and neutrons. Results for gamma-rays and reactor neutrons agree very well with BNL data for similar conditions. Four complete instruments are operational in the field. Acquisition of flight data is in progress and should be available for publication in the near future. (auth)

28182 PRELIMINARY STUDY ON THE DOSIMETRY OF THE TOTAL NEUTRON DOSE. Lee, Hyun Duk (Atomic Energy Research Inst., Seoul). J. Nucl. Sci. (Seoul), 7: No. 1, 49-54(Oct. 1967).

A small europium-activated lithium iodide scintillator surrounded by a spherical polyethylene moderator is described for measuring neutron dose independent of energy. Sensitivity and calibration of the system are discussed. (W.H.K.)

28183 THE SUBSTITUTION OF A BF_3 PROBE FOR THE LiI CRYSTAL IN NEUTRON REM-METERS. Hawkins, D. E. (Los Alamos Scientific Lab., N. Mex.). Health Phys., 14: 518-20 (May 1968). (LA-DC-9054).

The detector of the 10-in.-sphere neutron rem-meter referred to consists of a small thermal-neutron sensitive LiI crystal located at the center of the sphere. Unfortunately, the crystal is also sensitive to gamma rays. The gamma-ray sensitivity of the remmeter increases as the energy increases, and for 6–7-MeV gamma-rays, such as those from ^{16}N, the gamma-ray sensitivity presents a problem. In order to reduce gamma-ray sensitivity, a BF_3 probe was substituted for the LiI crystal. (auth) (UK)

28184 EFFECTS OF TOTAL DOSE ON ENERGY DEPENDENCE OF TLD-100 LiF DOSIMETERS. Hendee, W. R.; Ibbott, G. S.; Gilbert, D. B. (Univ. of Colorado, Denver). Int. J. Appl. Radiat. Isotop., 19: 431-7(May 1968).

Harshaw TLD-100 LiF in polyethylene capsules was irradiated to doses of 20, 100, 400, 800 and 1500 rads. Radiation modalities used were 24, 36, 57 and 135 keV x rays and ^{60}Co gamma radiation. The powder was stored for 24 hr before readout to reduce errors resulting from short term fading. Photomultiplier high voltage for the readout instrument was selected for each dose from an optimum dose-voltage chart. Thermoluminescence ratios were obtained by dividing LiF response to each dose and x ray quality by luminescence from phosphor receiving an identical dose from ^{60}Co radiation. Ratios for each beam quality were plotted as functions of total dose. Straight lines with coefficients determined by the least squares method were drawn through experimental points for each beam quality. Energy dependence curves for each total dose were obtained from the straight lines. Increased luminescence at lower photon energies was observed for each total dose. Suppression of degree of energy dependence was apparent at higher doses. Decreased energy dependence of TLD-100 LiF dosimeters at higher doses was attributed to greater efficiency of ^{60}Co radiation in producing radiation-induced electron traps. (auth) (UK)

28185 MERCURIC CHLORIDE AS A LOW LEVEL γ-RAY DOSIMETER: RADIOLYTIC AND PHOTOLYTIC CONSTANTS AT VARIOUS pH. Oza, P. M.; Rao, P. S. (Central Salt and Marine Chemicals Research Inst., Bhavnagar, India). Z. Phys. Chem. (Frankfurt), 57: 265-8(Feb. 1968).

A dosimeter based on the mercuric chloride–oxalate photochemical reduction system in the range 240 to 300°R/ml (0.15 to 1.8×10^{17} eV/ml) is described with the radiolytic and photolytic constants determined at various pH. Some advantages of the dosimeter are the ease with which it can be made and estimated, the yields are independent of dose rate and total dose, and the G values are very reproducible (at pH 5). (D.H.M.)

28186 THERMAL TREATMENT EFFECTS ON LiF PHOSPHORS AS THERMOLUMINESCENT DOSIMETERS. Nakajima, Toshiyuki (National Inst. of Radiological Science, Tokyo). Oyo Butsuri, 37: 231-6(Mar. 1968). (In Japanese).

The sensitivity improvements on LiF phosphors as thermoluminescent dosimeters were made with the method of thermal treatments. In the investigation of thermal treatment method, the atmosphors used were air, nitrogen and argon gases. The thermoluminescent yields of the phosphor which were treated at 600°C in argon gas for 500 hr were given about 95% as compared with the yields of Harshaw TLD-100 LiF phosphors. In case of thermal treatments in air, LiF phosphors treated at 400°C had good sensitivity for exposure of ionizing radiation. But the treated crystals in air contained OH ion and its transmission decreased in comparison with original crystals. It was reported that poor sensitivity of treated phosphors in air at higher temperatures is caused by the killer action of OH ion for thermoluminescence phenomena and the decrease of transmission. (auth) (NSA of Japan)

28187 RECENT MEASUREMENT OF ENERGY DISTRIBUTION IN TISSUE OF ^{60}Co GAMMA RAYS: IMPROVEMENTS OF EXPERIMENTAL TECHNIC AND CALIBRATION METHOD. Srdoc, Dusan (Columbia Univ., New York). Contract AT(30-1)-2740. Radiology, 90: 368-9(Feb. 1968).

Improvements in experimental techniques and calibration methods for 1-in. spherical proportional detectors used to measure the energy distribution of ^{60}Co γ radiation in tissues are reported. A tissue-equivalent gas mixture that corresponds to a 0.2 μ diameter tissue sphere was used, to increase the gas multiplication factor. Counter geometry was changed and preamplifier noise was reduced. A miniature x-ray tube was constructed for use as a low-energy calibration source. (C.H.)

Radiometric Instruments

Refer also to abstracts 27898 and 28503.

28188 (NP-17351) UTILIZACION DE FUENTES DE RAYOS X POR EXCITACION CON RAYOS GAMMA, PARA LA DETERMINACION DE ESPESORES DE DEPOSITOS ELECTROLITICOS. (Use of γ-Excited X-ray Beams for Measurement of the Thickness of Electrolytic Deposits). Iturbe Hermann, Fernando (Universidad Nacional Autonoma de Mexico, Mexico City. Facultad de Quimica). 1967. 69p. (In Spanish). Dep.

Thesis.

A review is given of atomic structure with respect to the excitation of x rays. The characteristics of x rays and their production are described. The x-ray sources using γ excitation are described in some detail. The application of these sources to the measurement of thicknesses is illustrated with some examples. (J.S.R.)

28189 BORE-HOLE NEUTRON GENERATOR. Khrustsel, Edvard; Dombek, Tadeush; Korbel, Kazimet; Massal'ski, Ezhi; Ovsyak, Tadeush; Studnitski, Yul'yak (Inst. of Nuclear Techniques, Krakow). Nukleonika, 13: 201-13(1968). (In Russian).

The bore-hole generator, producing fast neutrons of 14 MeV, is described. It consists of a geophysical type probe of 140 mm diameter and 3500 mm length, and the corresponding surface arrangement. The probe incorporates a neutron generating tube, H. T. transformer (50 kV), secondary radiation detectors and the

electronic units producing the pulsed action of the neutron tube as well as permitting the transmission of the signal to the surface of the earth. The secondary radiation produced in the bore-hole is selected and stored by means of a four channel time-analyzer. (auth)

28190 NEUTRON DIFFRACTION METHOD FOR SHEET TEXTURE DETERMINATION. Oles, Andrzej (Inst. of Nuclear Techniques, Krakow); Szpunar, Jerzy; Sosnowska, Izabella. Nukleonika, 13: 171-6(1968).

The neutron diffusion method for texture investigations of metal sheets is described. The method has been checked experimentally at the EWA reactor at Swierk. The application of the neutron diffraction method for sheet texture determination seems to be especially valuable in the case of coarse grain sheets. (auth)

28191 NEUTRON MOISTURE MEASUREMENTS BY CONTINUOUS- AND POINT-LOGGING PROCEDURES. Prill, Robert C.; Meyer, Walter R. (State Geological Survey of Kansas, Garden City. Kansas State Department of Health, Garden City. Kansas State Board of Agriculture, Garden City). U. S., Geol. Surv., Prof. Pap. 600-B, 226-30(1968).

A recently developed neutron meter records moisture measurements by continuous and point-logging procedures. Field calibration of the meter shows a linear relationship between the instrument reading and the moisture content over a range of 5 to 40 percent moisture by volume. Comparison of neutron moisture logs obtained by different logging procedures illustrates that a compromise must be made between logging time, bed definition, and curve reproducibility. Tests indicate that the point-logging procedure, using close logging intervals, provides the more accurate logs. However, the continuous-logging procedure, which requires much less time and manual operation, can provide acceptable logs for many moisture studies. (auth)

28192 COKE MOISTURE MEASUREMENT. Schmidt, M. H. (Bethlehem Steel Corp., Johnstown, Pa.); Oshinski, C. C.; Laslo, J. A. J. Metals, 20: 61-4(Feb. 1968).

A radiometric gage for measuring coke moisture has been used to correct natural coke weights to the furnace and as a guide to the coke plant operators to reduce the variations in coke moisture. The instrument consists of a bulk density meter using gamma rays, a hydrogen density meter using neutron emission, and a computer to calculate weight percent coke moisture from the ratios hydrogen density/bulk density. (W.H.K.)

28193 COEFFICIENTS OF SLOWING DOWN OF GAMMA RADIATION OF SOME ROCKS AND MINERALS. Filippov, E. M. Geol. Geofiz., Akad. Nauk SSSR, Sib. Otd., 152-68(1966). (In Russian).

Using effective atomic number to calculate the gamma ray slowing down coefficients in a substance gives only an approximate value. A more accurate way of calculating these coefficients is given here. Data obtained by this method for a very wide range of rocks and minerals are compared with air, water, Al, Fe, and Pb data in a table. As rock compositions are usually reported in oxides, the mass coefficients of gamma ray slowing down are tabulated for the 13 most common oxides reported in rocks. For most rocks with high gamma quantum energies the mass coefficients vary, being lower in the range where the photoeffect predominates over the Compton effect and higher where the latter predominates over the former. (Geophys. Abstr.)

28194 USE OF THE METHOD OF BACK SCATTERED BETA RADIATION TO DETERMINE THE CONTENT OF SOME ELEMENTS IN ROCKS AND ORES. Filippov, E. M.; Rusyaev, V. G.; Kuznetsov, G. A. Geol. Geofiz., Akad. Nauk SSSR, Sib. Otd., 130-51(1966). (In Russian).

Study of the possibilities of using reflected beta radiation to determine some elements in rocks and ores leads to the conclusions that (1) the quantitative composition of a substance containing two known elements with a very different atomic number can be determined with high accuracy; (2) the quantitative composition of a substance containing three such elements can be determined only from a set of measurements made with two different filters; (3) the method can be used mainly for determining the ash content of coals in outcrop, potassium at the face of mine workings, and Fe, Hg, Sb, Pb, W, Ba, Mn, and so forth both in outcrop, on mill concentrates, and in the laboratory; and (4) use of this method in geological surveying and mining can considerably enhance the efficiency of the operations and reduce expenditures for analyses of mineral raw materials. (Geophys. Abstr.)

28195 ON THE SENSITIVITY OF SUBSURFACE NEUTRON MOISTURE GAUGES TO VARIATIONS IN BULK DENSITY. Oelgaard, P. L.; Haahr, V. (Research Establishment Risoe, Roskilde, Denmark). Soil Sci., 105: 62-4(Jan. 1968).

Comments on a recent contribution to Soil Science by J. W. Holmes which discussed the influence of bulk density of the soil on neutron moisture gage calibration are presented. A response of J. W. Holmes to Olgaard and Haahr comments is included. (B.G.D.)

28196 SURFACE ANALYSIS OF OXYGEN BY ALPHA PARTICLE SCATTERING. Roehm, H. F. Stellenbosch, S. Africa, Univ. of Stellenbosch, 1966. 121p.

Thesis.

The technique of analyzing surfaces by elastic scattering of helium ions has been applied to the quantitative study of the thickness of oxide films produced on aluminium by anodization. Aluminium foils were anodized at different voltages in triammonium citrate baths. The oxide film thicknesses were standarized from independent measurement of the oxygen content of the anodized foils by helium-3 activation analysis and from the known linear growth of film thickness with anodizing voltage. The energy spectra of singly charged helium-4 ions scattered through a laboratory angle of 135° from an incident beam of 1000 keV particles showed the presence of surface aluminium and oxygen, as expected, but in addition gave the maximum energy of the particles scattered from the aluminium backing. The variation of the latter energy was found to be a sensitive measure of the oxide film thickness and enabled films from about 10 to over 100 μgs per cm^2 to be measured with a relative precision of ±3%. Thin self-supporting alumina films were similarly analyzed by the scattering of accelerated alpha particles. The presence of each element was found as separate peaks in the energy spectrum of the alpha particles, but the separation between the two peaks decreased with increasing film thickness. The integrated count under either or both peaks served as a measure of the film thickness. Comparison of the number of counts obtained from the oxygen and aluminium in alumina, showed that the Rutherford scattering cross section of the aluminium had to be corrected by a comparatively small but constant term to fit the 2:3 atomic ratio of aluminium to oxygen. This correction was ascribed to shielding by the oxygen atoms arranged octahedrally and tetrahedrally around central aluminium atoms. On careful examination the spectrum peaks related to oxygen and aluminium in thin alumina both proved to be unresolved composite peaks. The protruding portion was interpreted as being due to a region of higher density within the film, formed at the seat of growth during the initial stage of anodization. (auth)

28197 THE STUDY OF BACKSCATTERED β-RAY AND ITS APPLICATIONS. Jae, Won Mok; Kim, Kyung Eung (Hanyang Univ., China). J. Nucl. Sci. (Seoul), 7: 135-40(Oct. 1967). (In Korean).

Absorption curves of backscattered beta radiation were determined by aluminum absorber with $^{90}Sr-^{90}Y$ beta emitting isotope. It was found that the relative counting rates of backscattered beta radiation (standard activity was taken as Pb activity = 1) were increased as the difference in atomic number of backing material and the thickness of aluminum absorber. It was impossible to increase relative counting rate using a thick absorber, because of statistical errors of the counting rate. It was possible to determine the optimum condition for the aluminum absorber by the experiments of backscattered beta radiation. The concentrations of solutions of $Bi(NO_3)_3$ and $Sr(NO_3)_2$ and ratios of smokeless coal and soil were determined at optimum absorber conditions. It was found that industrial analysis was possible within ±5% accuracy. Also by the backscattered beta radiation the thickness of paper and paint was determined and some advantages of the backscattered method over the absorption method were found. Finally, the relations of particle size and backscattered radiations were investigated, and it was found that linearity existed between particle size and backscattered radiations. (auth) (NSA of Japan)

28198 METHOD FOR THE ELECTRONIC REGULATION OF A PLUTONIUM EXTRACTION BATTERY. Degryse, Michel; Riolfo, Rene (to Commissariat a l'Energie Atomique). British Patent 1,111, 959. May 1, 1968. Priority date June 29, 1965, France.

A system for automatically controlling the ratio of the solvent flow rate for a countercurrent separation system for separating plutonium from fission fragments and uranium is described. The flow rate is determined by plutonium retention in the batteries which is measured with a group of neutron detectors. (W.H.K.)

28199 DEVICE FOR MEASURING THE CHARACTERISTICS OF A MATERIAL MOVING ON A CONVEYOR WITH MEANS FOR MINIMIZING THE EFFECT OF FLUTTER. Han, Linus K. (to Industrial Nucleonics Corp.). U. S. Patent 3,373,286. Sept. 18, 1964.

The design of a collimator for radiometric instruments for minimizing the effects of the movement of the material being tested is presented. The angular collimator described maximizes

the amount of radiation that reaches the detector and increases the signal-to-noise ratio of the detector. (W.H.K.)

28200 IONIZING RADIATION DOSE RATE MEASURING DEVICES INCLUDING UTILIZATION AS GAS DENSITY METERS. Falk, Fred W. (to Secretary of the Army). U. S. Patent 3,373,282. Feb. 13, 1964.

The design of a proportional detector for measuring dose rate and which may be used for measuring gas density is presented. A grid element is included for reducing space charge around the anode. (W.H.K.)

Miscellaneous Instruments and Components

Refer also to abstracts 28474, 28567, 29416, and 29931.

28201 (AERE-R-5695) A HIGH-TEMPERATURE ATTACHMENT FOR USE WITH THE PHILLIPS X-RAY DIFFRACTOMETER. Harper, E. A. (Atomic Energy Research Establishment, Harwell (England)). Feb. 1968. 22p. Dep. CFSTI. UK.

A high temperature attachment for a Philips x-ray diffractometer has been built which enables 2θ values from 0 to 140° to be scanned in vacuum or an inert-gas atmosphere at temperatures up to 2500°C. The apparatus was designed for use with plutonium or similar α-active materials. A satisfactory low leak rate for the system has been demonstrated by observing the x-ray lines from U metal and UC at 900°C and 1000°C respectively. Investigations made on UC_2, UO_2 and UO_{2-x} are reported on briefly to illustrate the potential applications of the equipment. (auth)

28202 (DESY-68/12) MEASUREMENT OF THE POLARIZATION OF EXTREME ULTRAVIOLET SYNCHROTRON RADIATION WITH A REFLECTING POLARIMETER. Rosenbaum, G.; Feuerbacher, B.; Godwin, R. P.; Skibowski, M. (Munich Univ. (West Germany). Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Mar. 1968. 15p. Dep.

Thesis. Submitted by G. Rosenbaum.

The polarization of extreme uv light provided by a normal-incidence monochromator used with synchrotron radiation from the 6-GeV electron synchrotron DESY has been measured. The measured polarization increases from 82% at 500 Å to 87% at 1000 Å and is in excellent agreement with the calculated polarization of the light incident upon the monochromator grating. A reflecting polarimeter consisting of a polarizer and an analyzer each made of four gold mirrors has been used in the measurement. (auth)

28203 (FEI-95) O VOL'T-AMPERNYKH KHARAKTERISTIKAKH NIZKOVOL'TNOGO DUGOVOGO RAZRYADA. (Volt-Ampere Characteristics of Low-Voltage Arc Discharge). Stakhanov, I. P.; Kasikov, I. I. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Obninsk. Fiziko-Energeticheskii Institut). 1967. 23p. (In Russian). Dep.

An approximate analytic formula is derived for the volt–ampere characteristic with negative resistance for low-voltage arc discharges. It is shown that in the absence of recombination the arcing temperature weakly depends on the current and the interelectrode distance. When the ionization losses are low the branch of the volt-ampere characteristic with negative resistance is realized. As the losses increase, the curve of the characteristic becomes normal. (JPRS)

28204 (GEPP-27) SELF-CHECK FEATURES FOR PRODUCT TESTER. Rowe, W. M. (General Electric Co., St. Petersburg, Fla. Neutron Devices Dept.). Apr. 23, 1968. Contract AT(29-2)-656. 6p. (CONF-680416-1). Dep. CFSTI.

From Test Equipment Symposium, Albuquerque, N. Mex.

An automatic self-check system for testing neutron generator circuits is described. This system reduces the time needed to check, calibrate, and troubleshoot the product tester. (W.H.K.)

28205 (GEPP-32) DIGITAL MASS SPECTROGRAPHIC PLATE READER. Bonham, R. W.; Humphries, J. O. (General Electric Co., St. Petersburg, Fla. Neutron Devices Dept.). May 13, 1968. Contract AT(29-2)-656. 13p. (R-68-ND-9). Dep. CFSTI.

An integrating mass spectrographic plate reader that has been developed to reduce the time required for spark source analyses is described. This unit, used in conjunction with a standard scanning densitometer, features digital readout and a background compensation circuit. The use of this digital plate reader in spark source mass spectrographic analyses provides a definite improvement in precision and reliability, minimizes operator errors, and reduces evaluation time from four to five hours to about one hour. (auth)

28206 (IFA-FN-33) NEUTRON DIFFRACTOMETER OF THE INSTITUTE FOR ATOMIC PHYSICS (BUCHAREST). Gheorghiu, Z.; Dutescu, N.; Gelberg, D.; Bally, D. (Academia R.P.R., Bucharest. Institutul de Fizica Atomica). 1968. 14p. Dep.

The construction and operation of a neutron diffractometer for studying single crystals and polycrystalline powders which is mounted at one of the WWR-S reactor horizontal channels is described. The results of the resolution and intensity measurements on a Ni powder sample compared with theoretical data are also given. (auth)

28207 (NP-17355) EL DETECTOR DE SECCIONES TRANSVERSALES Y SU APLICACION EN EL ANALISIS DE GASES. (The Cross Section Detector and its Application in the Analysis of Gases). Del Campo Maldonado, Jose Luis (Universidad Nacional Autonoma de Mexico, Mexico City. Facultad de Ciencias). 1967. 56p. (In Spanish). Dep.

Thesis.

The physical principles on which ionization chambers are based are described. Some fundamental aspects of gas chromatography and the apparatus used are also considered. The design of a flowthrough ionization chamber with an internal standard radiation source for gas analysis is presented. Experimental results are presented. (J.S.R.)

28208 (NP-17365) COMPARACION DE VARIOS METODOS PARA MEDIR ESPESORES PEQUENOS. (Comparison of Various Methods for Measuring Small Thicknesses). Barragan Vidal, Alberto (Universidad Nacional Autonoma de Mexico, Mexico City. Facultad de Ciencias). 1967. 43p. (In Spanish). Dep.

Thesis.

Three methods for the determination of thicknesses are described and compared. The three methods are weight difference using a microbalance, x-ray fluorescence, and Rutherford dispersion. The most rapid method is the weight difference method using a microbalance. The x-ray fluorescent method is simple, but it is subject to possible errors in the relative intensities of blanks because of the operational instability of the spectrograph and the small geometry. The Rutherford method is subject to systematic errors. (J.S.R.)

28209 (NYO-3906-2) ULTRASONIC THERMOMETRY IN LMFBR SYSTEMS. Second Quarterly Progress Report, January 1, 1968–March 31, 1968. Fam, S.; Lynnworth, L. C.; Carnevale, E. H. (Panametrics, Inc., Waltham, Mass.). Apr. 1968. Contract AT(30-1)-3906. 9p. Dep. CFSTI.

The development of an ultrasonic system to measure temperature in the coolant, cladding, and fuel meat of liquid metal-cooled fast breeder reactors is presented. Data are presented on the ultrasonic measurement of transit time across a liquid sodium path to determine sodium temperature. (W.H.K.)

28210 (UCRL-17999) ERROR-CORRECTING DATA LINK BETWEEN SMALL AND LARGE COMPUTERS. Andreae, Sypko W.; Lafore, Robert W. Jr. (California Univ., Berkeley. Lawrence Radiation Lab.). Jan. 16, 1968. Contract W-7405-eng-48. 19p. (CONF-680417-1). Dep. CFSTI.

From Spring Joint Computer Conference, Atlantic City, N. J.

A data link for connecting small data-acquisition computers to a central CDC 6600 computer is described. Operation and design problems are discussed. (W.H.K.)

28211 (UNC-SPLM-61) LIQUID METAL OXYGEN METER. Minushkin, B. (United Nuclear Corp., White Plains, N. Y. Development Div.). [nd]. Contract AT(30-1)-2877. 17p. (CONF-650946-5). Dep. CFSTI.

From 4th High Temperature Liquid-Metal Heat Transfer Technology Conference, Argonne, Ill.

An on-line electrolytic cell for continuously measuring the effective oxygen content in liquid metals is described. Performance characteristics such as rapid response to changes in oxygen content, insensitivity to changes in liquid metal temperature, and independence of liquid metal velocity are discussed. (W.H.K.)

28212 PULSE AMPLIFIER (Engineering Materials). (Dow Chemical Co., Midland, Mich.). (CAPE-1703).

2 drawings.

A 0 to 10 V general purpose nuclear pulse amplifier utilizing low cost linear and logic integrated circuits and plastic encased circuits is described. The maximum gain is 350, noise input 15 μV; the risetime is adjustable. Input and output pulse levels and polarities conform to the guides set for the AEC module series. A logic signal is included to be used with a Nuclear Data ND-120 multichannel pulse height analyzer. The unit can be housed in a single width AEC bin-mounted module. (For details see TID-4100 Suppl. 43.) (F.S.)

28213 IONIZATION TYPE VACUUM GAGE (Engineering Materials). (California Univ., Livermore. Lawrence Radiation Lab.). (CAPE–1722).

6 drawings.

A control and indicating circuit for the VG-IA ion gage tube is described. The ion gage is useful over a pressure range of from 10^{-2}mm Hg to 1×10^{-7}mm Hg for cable runs of up to 20 ft of AWG No. 20 (total resistance <0.5Ω). The total accuracy (worst case) is ±10%. The ac input circuit is protected by a 1A slow blow fuse which protects the power supply and ac circuits from shorts or overloads. (For details see TID-4100.) (F.S.)

28214 ELECTROMAGNETIC ISOTOPE SEPARATORS FOR LABORATORY PURPOSES. Alvaeger, T. (Univ., Stockholm); Uhler, J. Prog. Nucl. Tech. Instrum., 3: 159-246(1968).

A review of the development of electromagnetic isotope separators and the fundamental properties of laboratory separators are presented. The production and formation of ion beams and their mass analysis are discussed, and collection problems are described. (W.H.K.)

28215 THE CALIBRATION AND STABILITY OF A 1200°F PERMANENT MAGNET IN-CORE SODIUM FLOWMETER. Glass, M. C.; Popper, G. F. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: 37-40(Feb. 1968).

From 14th Nuclear Science Symposium, Los Angeles. See CONF-671026.

A permanent magnet in-core flowmeter for use in sodium cooled reactors has been fabricated and installed in the Argonne National Laboratory Sodium Flow-meter Calibration Loop. The calibration test facility and procedures are described and a typical family of flowmeter calibration curves are presented. The measured sensitivity is compared to that theoretically predicted and the discrepancies are discussed. Long term performance of the flowmeter is discussed. (auth)

28216 SUMMARY OF AN ANALYSIS OF THE EDDY-CURRENT FLOWMETER. Wiegand, David E. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: 28-36(Feb. 1968).

From 14th Nuclear Science Symposium, Los Angeles. See CONF-671026.

The eddy-current flowmeter seems well adapted to measurements in high-temperature liquid-metal systems where deterioration of the properties of permanent magnets and other ferromagnetic parts or bearing problems may seriously degrade the performance of other types. It is shown analytically that velocity-profile errors and temperature errors can be minimized by selecting a suitable operating frequency. (auth)

28217 METHOD FOR HIGH RESOLUTION AMPLITUDE MEASUREMENTS IN PRESENCE OF NOISE AND PILE-UP FLUCTUATIONS. Bertolaccini, M. (Istituto di Fisica del Politecnico di Milan); Bussolati, C.; Cova, S.; De Lotto, I.; Gatti, E. Nucl. Instrum. Methods, 62: 221-7(June 15, 1968).

The problem of achieving the highest resolution in the amplitude measurement of pulses randomly spaced in time is considered, taking into account both noise and pile-up fluctuations due to slow signal tails. Signals composed by a pulse of finite duration and a long tail, are considered: a measuring technique is introduced, based on a linear combination of sampling measurements on the pulse. It is shown that, by a suitable choice of weights, optimum compromise between noise and tail pile-up effects can be reached, allowing good resolution at high counting rates. Results of calculations are given for the well known finite width cusp pulse and exponential tails. (auth)

28218 RATIOMETER TO COMPENSATE COUNTING RATES FOR BEAM CURRENT FLUCTUATIONS IN CHARGED PARTICLE EXPERIMENTS SUCH AS CHANNELING. Walker, D. A. S.; McGann, L. E. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Nucl. Instrum. Methods, 62: 228-32(June 15, 1968).

A ratiometer has been designed to compensate for beam current variations when observing counting rates in such experiments as nuclear reactions, Rutherford scattering, and channeling. Using solid-state operational amplifiers and logarithmic elements we have produced an instrument which accepts the analog output signals from a count ratemeter and electrometer, applies an integrating time constant to the electrometer signal equal to that of the ratemeter, and produces an output equal to the ratio of these signals. The accuracy is better than ±0.5%. A typical application to channeling experiments is illustrated. (auth)

28219 HIGH SPEED CORRELATOR. Kindlmann, P. J.; Hooper, E. B. Jr. (Yale Univ., New Haven). Rev. Sci. Instrum., 39: 864-72(June 1968).

The real time computation of the correlation function of two signals of up to 2.5 MHz bandwidth at 30 points simultaneously has been achieved to an accuracy of better than 3% of reading ±2% of full scale by a probabilistic computational procedure. An oscilloscope display permits live observations. The maximum delay between the input signals can take values between 3 μsec and 48 msec, corresponding to delay increments of 0.1 μsec to 1.6 msec, derived from a crystal oscillator. The instrument offers an order of magnitude improvement in bandwidth and a decisive advantage in cost over commercially available units, while retaining compact size (23 × 48 × 38 cm). These features, as well as greatly simplified construction, were made possible by the extensive use of integrated circuits. The computational procedure and critical circuitry are described in detail, with briefer treatment given to auxiliary circuits and construction. (auth)

28220 AUTOMATIC SYSTEM FOR ACCURATELY MEASURING LARGE AREA MAGNETIC FIELDS POINT BY POINT. Roshop, R. (Allgemeine Elektricitaets-Gesellschaft AEG-Telefunken am Main). Kerntechnik, 10: 226-9(Apr. 1968). (In German).

The measurement system described permits a determination of magnetic field configurations over large air gaps (4m × 4m) with an accuracy of ±1G. This high accuracy is achieved by means of a small swivel-coil-drive detector feeding a sensitive voltage-frequency converter. The point of measurement can be located with an error below 50 μm in a cartesian coordinate system which is tape-operated by a numerical straight-line controller. The measured values for magnetic induction and the relevant coordinate references are directly fed into any large digital computer by means of tape or punched cards. The minimum time per measurement is 3 seconds. (auth)

28221 INCREASING THE DETECTION SENSITIVITY OF A HELIUM LEAK DETECTOR BY SUPPRESSION OF THE SCATTERED-ION BACKGROUND. Bueltemann, H.-J. (Varian MAT GmbH, Bremen). Kerntechnik, 10: 214-17(Apr. 1968). (In German).

In mass-spectrometric helium leak detectors, a scattered-ion current produced by large air inflow limits the effective detection sensitivity of the sniffing probe method. A retarding arrangement in front of the ion collector suppresses the scattered-ion current and increases the effective detection sensitivity by more than a factor of 10. This facilitates and expedites the tightness testing of pressure vessels which is primarily performed by the sniffing probe method. (auth)

28222 FREQUENCY SWEEP, FIELD-FREQUENCY STABILIZED DOUBLE RESONANCE SPECTROMETER. Boden, N.; Capart, J.; Derbyshire, W.; Gutowsky, H. S.; Hansen, J. R. (Univ. of Illinois, Urbana). Rev. Sci. Instrum., 39: 805-16(June 1968).

A description is given of circuits which improve both the performance and the versatility of a high resolution nuclear magnetic resonance spectrometer. Separate channels are provided for stabilization of the field-frequency ratio, for irradiation of any resonance, and for observing the spectrum in the frequency sweep mode. To maintain the operating frequencies of the observation and irradiation channels in constant proportion to the stabilization channel, all signals are derived from a single frequency synthesizer system. Essentially modular equipment is described to stabilize the base line and to isolate the receiver from the transmitter by the time sharing technique. The design and construction of a solid state (integrated circuit), field-frequency stabilizer are discussed in detail. Finally, the design of a stable audio frequency sweep oscillator, built from a voltage-to-frequency converter, is described along with a device for periodic repetitions of the sweep. (auth)

28223 ENERGY RESOLUTION AND FOCUSING IN INELASTIC SCATTERING EXPERIMENTS. Stedman, R. (Aktiebolaget Atomenergi, Studsvik, Sweden). Rev. Sci. Instrum., 39: 878-83(June 1968).

In elastic scattering experiments, it is appropriate to consider the scattering pattern in the space of momentum and energy transfers, and a proper treatment of resolution takes account of momentum and energy together, both as regards the correlation of momentum and energy increments in the beams of incident and scattered particles and as regards the structure of the cross section under observation. A description is given of the calculation of resolution widths in measurements on a phonon dispersion surface with a three-axis crystal spectrometer, and of the manner in which the two main contributions to the energy resolution width may be minimized by focusing—which involves a suitable choice of the monochromator and analyzer crystals, the beam path, and the incident and scattered energies. Focusing usually improves resolution markedly without loss of intensity, and often with a gain in the peak intensity of a recorded resonance. An experimental

illustration is given. Cases where focusing entails loss of intensity are discussed in connection with intensity formulas. (auth)

28224 COMPACT PORTABLE AIR SAMPLER FOR EMERGENCY USE. Boltin, R. L.; Cantelow, H. P.; Grill, R. P.; Haley, J. T.; Pearce, W. T.; Young, J. (Univ. of California, Berkeley). Health Phys., 14: 598(June 1968). (UCRL-17752).

A compact, versatile air sampler is described, which was built by the Health Chemistry Department of LRL-Berkeley. The sampler was designed to fit into a suitcase of emergency equipment which could be picked up at a moment's notice and carried to any remote area. Of prime importance were minimum weight and size; an adequate sampling rate was, however, necessary to justify the unit. (auth) (UK)

28225 RADIO FREQUENCY PULSE GENERATORS TO PRODUCE A 1.8 kG ROTATING FIELD IN A PLASMA. Lietti, A. (Laboratoire de Recherches sur la Physique des Plasmas, Lausanne, Switzerland). Rev. Sci. Instrum., 39: 900-3(June 1968).

A circuit is described which produces a 2.17 MHz rotating magnetic field at the surface of a cylindrical hydrogen plasma column of 5 cm diam and 44 cm length. The field has a duration of 3.7 μsec. Line pulse generators are used. The spark gaps of the lines are triggered by a special synchronizer. With this device a number of generators can be connected in parallel in order to achieve higher power levels. Fields of 10-20 kG for application outside of plasma physics are possible. (auth)

28226 INDICATING DEVICE FOR MEASURING THE LEVEL OF LIQUID HYDROGEN. Round, V.; Tayeb, G. (Ecole Normale Superieure, Orsay, France). Vide, No. 133, 40-2(Jan.-Feb., 1968). (In French).

The experiments done with the ORSAY Linear Accelerator required liquid hydrogen targets of various sizes. The problem was to have a precise indication of the level either in the targets or the reservoirs. An inexpensive apparatus which utilizes subminiature diodes is described. (auth)

28227 ELECTROMECHANICAL DRIVE EMPLOYING NEGATIVE FEEDBACK FOR MOESSBAUER EXPERIMENTS. Carmeliet, J.; Lejeune, S. (Univ., Brussels). Nucl. Instrum. Methods, 62: 166-8(June 15, 1968).

A servomechanism of an electrodynamic system used in Mössbauer spectrometry with linear or constant velocity is described. (auth)

28228 COLOR ISODOSE CURVE PLOTTER APPLIED TO BEAM FOCUS RADIOGRAPHY. Sakuma, Sadayuki (Nagoya Univ., Japan). Tohoku J. Exp. Med., 92: 265-70(July 1967).

An apparatus was constructed to facilitate superimposition of the beam focus radiogram upon the axial transverse tomogram, to guide subsequent radiation therapy more accurately, thereby avoiding excessive exposure of healthy tissue with adequate irradiation of tumor tissue. The apparatus automatically drew six isodose curves in three colors, by plotting the relative doses of the beam focus radiogram. In addition, an isodose chart was made at the same magnification as that of the axial transverse tomogram. A satisfactory and reliable technique was achieved. The accuracy and reproducibility of the apparatus were good. Clinical application of this method to a hypophyseal tumor was described. Conformation radiotherapy with the eyeball shielded was performed. The patient was positioned on the treatment table so that the center of the sella turcica coincided with the center of rotation of the unit. When the exposure dose at the center of the film placed on the rotation table of beam focus radiography was estimated to be about 12.5 R, irradiation was terminated. When the density of the film was measured, it was actually 12 R. With this radiogram, isodose curves in the range between 90% and 40%, at intervals of 10% lines, were drawn on translucent recording papers. To identify the relative positions of different isodose curves, the dots were drawn with different colors. The green dotted line indicated the 90% isodose line, the red line 80%, and the black line 70%. An isodose chart was thus obtained. The 90% isodose line obtained from the beam focus radiogram by this method was located about 1 to 2 mm inside the one drawn from data obtained actually by ionization chambers. The isodose lines of 80%, 70%, and 60% obtained from the beam focus radiogram coincided with those obtained by ionization chambers, while the 50% isodose line thus obtained was located about 2 to 3 mm outside that for the isodose curves obtained by measurement by ionization chambers. (BBB)

28229 CREEP STRAIN GAUGE FOR IN-PILE MEASUREMENTS ON REACTOR PRESSURE TUBES. Edwards, L.; McCalvey, L. F. (International Research and Development Co. Ltd., Newcastle-upon-Tyne, Eng.). Strain, 4: 4-8(Apr. 1968).

The creep gauge system described, based on a differential transformer and mechanical magnification, can measure a diametral expansion of less than 0.1×10^{-6} in./in. per hour on a 5 in. diameter tube at 300°C in a reactor environment. (auth)

28230 A LIQUID HELIUM POLARIMETER FOR FAST NEUTRONS. I. INSTRUMENTATION. Lam, S. T.; Gedcke, D. A.; Stinson, G. M.; Tang, S. M.; Sample, J. T. (Univ. of Alberta, Edmonton). Nucl. Instrum. Methods, 62: 1-12(June 1, 1968).

A liquid helium polarimeter for the measurement of neutron polarization in the 2 to 20 MeV energy range is described. A neutron time-of-flight technique is employed to resolve neutrons of different energy groups. For a 2 meter flight path, the energy resolution is between 6% and 7% for polarization measurements. The polarimeter operation has been checked with the $D(d,n)^3He$ reaction. Performance characteristics observed in $^{28}Si(d,n)^{29}P$ and $^{40}Ca(d,n)^{41}Sc$ experiments are reported. Practical operation is possible for reaction cross-sections as low as 1 mb/sr. (auth)

28231 CROSS-FIELD PHOTOMULTIPLIER WITH SUB-NANOSECOND RISETIME SUITABLE FOR NUCLEAR STUDIES. Lodge, J. A. (E. M. I. Ltd., Hayes, Eng.); Owen, R. B.; Smout, D.; Muff, P. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: 491-7(Feb. 1968).

From 14th Nuclear Science Symposium, Los Angeles. See CONF-671026.

A high-speed photomultiplier using crossed electric and magnetic fields has been made with a useful cathode area 1 cm × 2 cm. The output pulse risetime is 300 pS and full width at half maximum is 500 pS. This is shown to be close to the theoretical limits for this type of tube. Gain is about 10^7 and output is on two 50-ohm coaxial connectors. (auth)

28232 PERFORMANCE CHARACTERISTICS OF THE DIGITAL AUTOFLUOROSCOPE. Grenier, Raymond P.; Di Rocco, James V. (Baird-Atomic, Inc., Cambridge, Mass.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: 366-75(Feb. 1968).

From 14th Nuclear Science Symposium, Los Angeles. See CONF-671026.

The performance characteristics presented are: the characteristics of gamma photon imaging with the Digital Autofluoroscope, the resolution and efficiency of multihole and pinhole collimators, a quantitative discussion of the image distortion inherent in pinhole collimators and of the penetration of the pinhole edges. It is pointed out that the various correction modes available, such as normalization of stored data and background suppression, are a means of removing the image distortion evident with pinhole collimators and of restoring image quality loss due to penetration of septa and pinhole edges. Also discussed is the use of the pinhole collimator as a means of magnifying small organs and minifying large ones. (auth)

28233 ASPECTS OF RESOLUTION DEGRADATION IN A NUCLEAR PULSE ANALYZER SYSTEM. Hatch, Kenneth (Univ. of California, Livermore). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: 303-14(Feb. 1968). (UCRL-70527).

From 14th Nuclear Science Symposium, Los Angeles. See CONF-671026.

Common causes of resolution degradation are discussed for low and high count rates. Previous works have presented signal/noise versus shaping networks for Johnson noise and $1/f^2$ noise. Equations are derived here to include 1/f noise, which is found to be significant. Results are presented for peak-height change versus input rise time for different shaping networks. For high count rates, the need for an amplifier with long time constants and the use of a baseline restorer are discussed. A restorer and dead time gating curcuits are presented, along with experimental results. (auth)

28234 TIME TO PULSE-HEIGHT CONVERTER USING BITRIPOLES. Stanchi, L. (Joint Nuclear Research Center, Ispra, Italy). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: 315-22(Feb. 1968).

From 14th Nuclear Science Symposium, Los Angeles. See CONF-671026.

The exploitation of the apparent I, V characteristic of a tunnel diode when driven into high frequency oscillations was described and theoretically analyzed in three preceding papers. There was demonstrated the possibility of obtaining an accurate machine time associated to incoming events. A time to pulse-height converter based on the use of circuits (so-called bitripoles) exploiting this apparent characteristic is described. Some new elaborations of the basic circuit are described and first results are analyzed. A FWHM resolution of 77 ps with two XP1020 photomultiplier tubes driven by a hydrogen lamp was obtained. It seems that this figure can be decreased. (auth)

28235 APPLICATION OF ADC TECHNIQUE TO RATIO-CIRCUITS FOR YIELD-MASS DISTRIBUTION MEASUREMENTS.

Patwardhan, P. K.; Indurkar, V. S. (Bhabha Atomic Research Centre, Bombay). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: 323-31(Feb. 1968).

From 14th Nuclear Science Symposium, Los Angeles. See CONF-671026.

Mass distribution measurements employing the relationship $M_B/M_A + M_B = E_A/E_A + E_B$ using ratio circuits (pulse-voltage dividing circuits) are discussed. Topics include advantages of the ratio-techniques, fluctuations and linearity, application of analog-to-digital conversion techniques, design consideration, circuit details, system performance, electronic simulation and application to fission yield-mass distribution. (B.G.D.)

28236 SENSITIVITY COMPARISON OF THREE TRANSISTORIZED DC CURRENT-FEEDBACK ELECTROMETERS. Kennedy, E. J.; Pierce, J. F. (Oak Ridge National Lab., Tenn.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: 337-48(Feb. 1968). (ORNL-P-3465).

From 14th Nuclear Science Symposium, Los Angeles. See CONF-671026.

The theoretical equations for transistorized current-feedback dc electrometers have been developed and utilized for the design and evaluation of three electrometers containing (1) a bipolar transistor, (2) a junction field-effect transistor (JFET), and (3) a metal-oxide-semiconductor field-effect transistor (MOSFET) in the input stage. Each electrometer was evaluated in terms of input and output impedance, gain-bandwidth, drift characteristics, and output noise power spectra. For the experimental amplifiers, the measured minimum amplifiable dc input current was approximately 8×10^{-14} amp for the bipolar transistor electrometer, 4×10^{-15} amp for the JFET electrometer, and 5×10^{-16} amp for the MOSFET electrometer. (auth)

28237 NOVEL TECHNIQUE FOR PULSING A HIGH-MAGNETIC FIELD. Bates, D. D. (Oak Ridge National Lab., Tenn.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: 349-51(Feb. 1968). (ORNL-P-3460).

From 14th Nuclear Science Symposium, Los Angeles. See CONF-671026.

Radar modulator techniques, which make use of pulse-forming networks (PFN), were used to develop a magnet pulser which supplies 500-A current pulses to a 20-turn tape-wound coil for generating a pulsed, high magnetic field. Uniform fields of more than 5 kilogauss were generated with pulse widths of 6 to 14 μsec at repetition rates up to 1200 Hz. New cooling techniques for the load coil and the pulser components are being developed so that higher fields at higher repetition rates can be generated. (auth)

28238 NEW METHOD OF ADC FOR IMPROVING RESOLUTION. Colombo, G.; Stanchi, L. (Joint Nuclear Research Center, Ispra, Italy). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: 291-6(Feb. 1968).

From 14th Nuclear Science Symposium, Los Angeles. See CONF-671026.

A new method of ADC which reduces noise by the measurement of the signal area is described. The area is evaluated by an integrator which compares it to a number of elementary charges, this number being the digital value proportional to the energy of the detected particle. Further improvements of the method are indicated. (auth)

28239 PROGRAMS AND SYSTEMS FOR ON-LINE COMPUTERS IN LOW-ENERGY NUCLEAR PHYSICS. Lidofsky, Leon J. (Columbia Univ., New York). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: 93-102(Feb. 1968).

From 14th Nuclear Science Symposium, Los Angeles. See CONF-671026.

Some of the programming approaches which are in use or are under development for handling all or some features of experimental procedures in nuclear physics are described. Topics discussed are extreme modular systems such as the UCRL system and NBS system; data acquisition-wired programs such as in the Yale-IBM system, BNL system, and Oxford system; data acquisition-stored programs such as in the Rochester system and INPR Amsterdam system, display and auxiliary memory; representative programming systems such as Argonne data handling system, and Yale-IBM data handling system; experiment control including digital control of fast neutron laboratory, and computer-controlled charged-particle scattering measurements; and delayed time processing such as in the Amsterdam system. (B.G.D.)

28240 PROGRAMMING FOR AN ADVANCED NUCLEAR PHYSICS DATA ACQUISITION SYSTEM. Birnbaum, J. (IBM Watson Research Center, Yorktown Heights, N. Y.); Gelernter, H. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: 109-16(Feb. 1968).

From 14th Nuclear Science Symposium, Los Angeles. See CONF-671026.

Experience in the design and operation of a hardware-software computer-based on-line nuclear physics data acquisition system previously reported by H. L. Gelernter, et. al., (Nucl. Inst. and Meth. 54: 77(1967)) is described. Major emphasis is placed upon the structure of the programming system, which embodies data acquisition, display, control, and analysis facilities, and a supervisor capable of coordinating the parallel operation of multiple tasks. Basic concepts, rather than details, are stressed throughout. (auth)

28241 A COMPUTER P.H.A. SYSTEM FOR REAL TIME OFF LINE ANALYSIS OF SPECTRA FROM AN AERIAL SURVEY FOR RADIOACTIVE MINERALS. Bristow, Q.; Thompson, C. J. (Atomic Energy of Canada Ltd., Ottawa). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: 150-6(Feb. 1968).

From 14th Nuclear Science Symposium, Los Angeles. See CONF-671026.

A system for real time pulse height analysis of γ ray spectra recorded on magnetic tape in an aircraft is described. A pulse height to width converter is used to record pulses, whose original amplitudes are proportional to the γ ray energies, on magnetic tape. The stored pulse widths are subsequently fed into a Digital Equipment Corporation PDP-9 computer via an interface which digitizes the widths using high speed integrated circuit counting logic. (auth)

28242 USE OF COMPUTER GRAPHICS IN THE DEVELOPMENT OF AN AUTOMATED NEUTRON CROSS SECTION EVALUATION SYSTEM. Alter, H. (Atomics International, Canoga Park, Calif.); Dunford, C. L.; Berland, R. F.; Creasy, R. J.; Joanou, G. D. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: 167-9(Feb. 1968).

From 14th Nuclear Science Symposium, Los Angeles. See CONF-671026.

In order to analyze the increasing quantity of new experimental neutron cross section data from the present, highly automated, experimental facilities, new automated evaluation techniques are being developed. The extent to which automation has already affected the evaluation process has been previously described. However, an unacceptable amount of manual effort is still required to produce an evaluated neutron cross section library for an isotope or element for use in nuclear reactor physics design. Hence, the greater portion of any evaluation is concerned with purely mechanical operations, leaving insufficient time for extensive evaluation of the available data and causing long delays between the generation of new data and its availability for use in reactor design studies. (auth)

28243 USE OF LOCAL LINEAR TRANSFORMS TO REDUCE THE SIZE OF A TWO-DIMENSIONAL ASSOCIATIVE MEMORY. Haines, Eldon L. (California Inst. of Tech., Pasadena). Contract NAS 7-100. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: 170-4(Feb. 1968).

From 14th Nuclear Science Symposium, Los Angeles. See CONF-671026.

Associative memory scheme for the analysis of two-dimensional data where the variables are transformed before data accumulation is discussed. Local linear transforms reduce the number of associative locations required, while a two-dimensional search scheme shortens the search among the fewer locations. Application of these methods results in some saving of memory space and an appreciable saving in excution time. (auth)

28244 DEWPOINT DEVICE FOR HTGR COOLANT. Roes, John B. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: 41-5(Feb. 1968). (GA-8033).

From 14th Nuclear Science Symposium, Los Angeles. See CONF-671026.

A dewpoint detector has been developed suitable for a wide range of dewpoint levels. The device may be used in relatively inaccessible areas, under limited γ radiation. This detector may be used as a fast trip device to detect when the sample stream has a moisture content in excess of a preset level and can also operate as an automatic dewpoint monitor between -87 and +128°F. The detector head is designed to operate at pressures of up to 1000 psi and at temperatures up to 175°F. By using very conservative design criteria, it is expected that the detector head will operate without maintenance for six-year intervals. (auth)

28245 PROCESSING EFFICIENCY OF INTERACTING DATA STREAMS. Murray, G. L.; Macefield, B. E. F. (Oxford Univ.). Nucl. Instrum. Methods, 62: 122-4(June 1, 1968).

Simple expressions are derived for the calculation of processing efficiency of interacting data streams (e.g., when a number of analog-to-digital converters share one or more input channels of a computer). An expression is also found for the percentage of computer time taken for servicing the encoders. (auth)

28246 BASIC STUDIES ON TWO-PHASE FLOW WITH THE USE OF ELECTRICAL VOID-METER. Kakizawa, Ken-ichi; Sakurai, Yoshifumi (Osaka Univ.). J. Nucl. Sci. Technol. (Tokyo), 5: 153-9(Apr. 1968).

Further basic knowledge has been gained on the behavior of two-phase flow through the following experiments. An electrical void-meter based on transducement of void fraction into impedance is employed to measure the void distribution along a heater in an annular channel. Experiments have further been conducted on the "velocity slip ratio (V_g/V_l)" to correlate the void-fraction (R_g) with the volume flow rate ratio (F_g). The resulting equation takes the form $R_g = 0.92 \cdot F_g$, and the ratio $V_g/V_l = 1.08$, for slug flow in a vertical pipe. Statistical methods have been applied in analyzing the two-phase flow. It is shown that the speed of voids in a two-phase flow can be determined with a cross-correlation function calculated from two time series of void-fraction fluctuation measured at two points along the channel. (auth)

28247 FLASH X-RAY ACTUATED TRIGGER SWITCH. Swift, H. F.; Strader, E. (Univ. of Dayton Research Inst., Dayton, Ohio). Rev. Sci. Instrum., 39: 728-30(May 1968).

A trigger switch system actuated by high intensity x-ray pulses has been developed and is being used with flash radiography equipment. Ten-kilovolt, low-impedance output pulses are initiated by the trigger system within 10 nsec of x-ray pulse initiation. The switch assembly causes little attenuation or scatter of the x-ray beam since the only material intercepted by the beam is two aluminum sheets, 25 μ thick. (auth)

28248 PRECISION HIGH SPEED CURRENT REGULATORS FOR OCCASIONALLY SWITCHED INDUCTIVE LOADS. Redfield, Alfred G.; Fite II, Warner; Bleich, Hermann E. (Columbia Univ., New York). Rev. Sci. Instrum., 39: 710-15(May 1968).

Power supplies used in field-cycling nuclear resonance experiments are described. These are used to switch an air coil from high field to low field as rapidly as possible, then back to high field after a short time. This sequence must be repeated every few seconds or minutes. An example of a simple regulator is described, and methods of output switching with relays are discussed. A circuit is described which delivers up to 10 kG (15 A) in a 2.6 cm ID superconducting coil with a switching speed of 5×10^5 G/sec and an accuracy probably as great as 1 G. Speed is achieved by automatic connection, during up or down switching, of energy storage capacitors across the magnet, operating at much higher voltage than the steady-state voltage level across the magnet and pass transistors. (auth)

28249 FAST METAL-TO-METAL SWITCH WITH 0.1 μSEC JITTER TIME. Dokopoulos, P. (Association EURATOM–KFA, Juelich, Ger.). Rev. Sci. Instrum., 39: 697-9(May 1968).

A fast mechanical switch of plane configuration with foil insulation is described. Its closure is ensured by an exploding aluminum foil. With 0.4 mm insulation and a 500 kA current rating the switching time is 2.4 ± 0.17 μsec. An increase of the insulation thickness and of the current rating increases the delay, but in a wide range of parameters the jitter time remains practically constant. The switch has been successfully used for series and crowbar operation on a circuit having a voltage of 18 kV, a frequency of 25 to 50 kHz, and a current of several hundred kiloamperes. When the switch components are so assembled to suppress all air gaps in the vicinity of the exploding foil, the jitter time can be brought down to 0.07 μsec. (auth)

28250 THERMAL EXPANSION OF EPOXIES BETWEEN 2 AND 300°K. Hamilton, W. O. (Stanford Univ., Calif.); Greene, D. B.; Davidson, D. E. Rev. Sci. Instrum., 39: 645-8(May 1968).

A simple apparatus for measuring relative thermal expansions down to very low temperatures is described. The thermal expansions are given for a number of commercial epoxy resins. The effect of loading epoxies with fused quartz powder is described. Several epoxies are found to match the thermal expansions of the common metals. (auth)

28251 MINIATURE HIGH TEMPERATURE GRAPHITE FURNACE. Chang, Ji Young (Oak Ridge National Lab., Tenn.). Rev. Sci. Instrum., 39: 756-60(May 1968). (ORNL-P-3567).

The construction of a miniature high temperature graphite resistance furnace is described. It has the unique feature of enabling thermal cycling in vacuum up to 2800°C in a short period (30 sec/cycle). The heating time required to reach 2800°C from room temperature in a 10^{-5} torr vacuum is 10 sec, and the cooling rate from 2800 to 800°C is 200°C/sec. (auth)

28252 AUTOMATIC TRANSISTORIZED GE-3 ELECTRON GAMMA EXPONOMETER. Skibenko, V. G.; Gostishchev, V. S. Defektoskopiya, No. 1, 83-6(1968). (In Russian).

Descriptions are given of the operation and construction of a transistorized γ exponometer designed for automatic calculation of the exposure time during radioisotope γ-ray photography of materials and manufactured goods. (tr-auth)

28253 SIMPLE LIQUID HELIUM PRESSURE TRANSDUCER. Chester, M.; Choudhery, S. C.; Jones, B. K.; Williams, D. (Univ. of California, Los Angeles). Rev. Sci. Instrum., 39: 719-22 (May 1968).

A totally immersed capsule type pressure transducer has been developed for the study of critical velocities in liquid helium below the lambda point. The construction and operation of the pressure transducer is described. It can be made in a few hours using relatively simple laboratory construction techniques. Typically it has a sensitivity between 50 and 100 cps/mm He at a frequency of about 10 Mc/sec and at an ambient pressure of a few millimeters of mercury. Such a transducer is particularly useful in closed systems—liquid helium not at its vapor pressure—for accurate measurements of the absolute pressure and for measuring small pressure changes. The operation of the transducer spans the pressure range from a fraction of a micron to several atmospheres with increased sensitivity at the lower pressures. (auth)

28254 METHOD OF CONTINUOUS AND AUTOMATIC MEASUREMENT OF THE GAMMA-RAY EMISSION OF A SOLUTION AND A DEVICE FOR THE APPLICATION OF SAID METHOD. (to Commissariat a l'Energie Atomique). Canadian Patent 775,666. Jan. 9, 1968. Priority date Apr. 5, 1966, France.

In a measurement cell having parallel sides two photomultiplier-scintillator assemblies receive γ emission from equal volumes of liquid. The two scintillator areas involved, however, are unequal so that a different number of pulses are counted in equal times by each of the two assemblies. A formula is given which allows the calculation and display of the activity per unit volume from the two sets of pulses. The cell is lead lined except in the collimators leading to each scintillator. (F.S.A.)

28255 OSCILLOSCOPE CAMERA MODEL LC4 (Engineering Materials). (California Univ., Livermore. Lawrence Radiation Lab.). (CAPE-1694).

169 drawings.

A camera used individually or in multiples to photograph high-speed fluorescent traces (waveforms) displayed on oscilloscope cathode ray tubes is described. Three available film packs permit the use of Polaroid film, cut film, or 35 mm film. The basic camera consists of the transition housing and the camera front assembled into an operating configuration which will provide mounting for any of the three available film backs. The camera parts are packaged in a shock-resistant carrying case. (For details see TID-4100 Suppl. 45) (F.S.)

28256 PULSE GENERATOR AND DISCRIMINATOR (Engineering Materials). (California Univ., Livermore. Lawrence Radiation Lab.). (CAPE-1716).

118 drawings.

A redundant type pulse generator is described which consists of two complete pulse generators driving a common set of output connectors. Each pulse generator has its own power supply and interlock relays. The generators share the ac input connector, ac switch, trigger mode switch, and internal repetition rate control. The two pulse generators, called sides, are connected so as to trigger both sides should only one side receive an input signal, insuring complete lock-out when used in the lock-out mode. With this cross connection only one internal rep-rate circuit is needed. (For details see TID-4100 Suppl. 45) (F.S.)

28257 MASS SPECTROMETER EQUIPPED WITH A HIGH-FREQUENCY ION SOURCE AND AN ELECTRONIC DIGITAL DEVICE FOR INFORMATION PROCESSING: APPLICATION TO ISOTOPIC ANALYSIS. Huynh, C. T.; Garcia, J.; Espagno, L. (Centre de Recherches, Pau, France). Rev. Phys. Appl., Suppl. J. Phys., 3: 33-45(May 1968). (In French).

A mass spectrometer is described which is equipped with a high frequency ion source and with an electronic digital device for information processing. This mass spectrometer has a 10 cm radius separator tube and input and output slits of 0.5×8 mm, and delivers to the ion collector a current of the order of a microampere. Its resolving power is, with these slits, equal to 80. The variations of the ion current collected have been studied for different gases with respect to the principal parameters: ion acceleration field and partial gas pressure in the source. The collected current increases with the acceleration field while the dispersion in ion energy decreases. Furthermore, it is shown that the variation of collected current is not a linear function of the gas introduction pressure. Application to analysis problems is however possible if the gas samples are diluted in an inert gas (helium for example).

Finally, results are reported of the application of this apparatus to the continuous analysis of isotopes partially separated by gas chromatography. (auth)

28258 EFFECT OF THE DIMENSIONS OF AN OMEGATRON ON ITS PERFORMANCE. Petley, B. W.; Morris, K. (National Physical Lab., Teddington, Eng.). J. Phys. E, 1: 417-22(Apr. 1968).

The way in which the dimensions of an omegatron limit its applications as a mass spectrometer are discussed, and the reason why most omegatrons have a comparable performance in the same magnetic field is explained. An approximate derivation of the shape of the resonance, and an explanation of why the trapping voltage must be optimized, are also given. Some possible new designs of omegatron are suggested. (auth)

28259 A LIQUID HELIUM POLARIMETER FOR FAST NEUTRONS. II. ANALYZING POWER CALCULATIONS. Stinson, G. M.; Tang, S. M.; Sample, J. T. (Univ. of Alberta, Edmonton). Nucl. Instrum. Methods, 62: 13-18(June 1, 1968).

The effective analyzing power of the neutron polarimeter described in the previous article is calculated by numerical integration. Also presented is a detailed study of double scattering within the cryostat. The dependence of double scattering upon detector angle, size of cryostat, and incident neutron energy is obtained. It is found that the correction for double scatter is more important than that for finite geometry. With minor modifications, the computer code written for the calculation can be adapted to other polarimeters. (auth)

28260 SUITABILITY OF LIQUID SEMICONDUCTORS FOR RESISTANCE THERMOMETRY IN NUCLEAR REACTORS. Edmond, J. T.; Male, J. C.; Chester, P. F. (Central Electricity Research Labs., Leatherhead, Eng.). J. Phys. E, 1: 373-8(Apr. 1968).

Liquid semiconductors are considered for use as temperature measuring elements in nuclear reactors. Several possible compositions in the system As–S–Se–Te–Ge were studied. The compositions are liquid above about 300°C, have temperature coefficients of resistivity of 1 to 5% per deg C between 250 and 675°C, and show negligible tendencies to devitrification. Irradiation tests were carried out on both the materials themselves and on experimental thermistors in order to assess susceptibility to γ-ray induced photoconductivity and fast neutron damage with encouraging results. Possible temperature misindications due to transmutation effects and local gamma heating are shown to be small and calculable. (auth)

28261 PARABOLA SPECTROMETER FOR THE INVESTIGATION OF FISSION PRODUCTS. Armbruster, P.; Ewald, H.; Fiebig, G.; Konecny, E.; Lawin, H.; Wollnik, H. (Univ., Giessen, Ger. Nuclear Research Centre, Juelich, Ger.). Ark. Fys., 36: 305-10(1967).

From International Symposium on Why and How Should We Investigate Nuclides Far Off the Stability Line, Lysekil, Sweden. See CONF-660817.

The planned design of a focusing parabola spectrometer for the separation of fast, unslowed fission products, which will be built by a cooperation of the II. Physical Institute of the University of Giessen and the Institute for Neutron Physics of the Nuclear Research Centre Jülich, is discussed. (auth)

28262 AUXILIARY EQUIPMENT FOR TUNING AND TESTING INSTRUMENTS OF NUCLEAR GEOPHYSICS. Varvarin, G. B.; Rusyaev, V. G. Geol. Geofiz., Akad. Nauk SSSR, Sib. Otd., 216-23(1966). (In Russian).

A number of electron supply sources, pulse generators, and auxiliary equipment needed in laboratory and field conditions for working and tuning the various electronic elements and units of applied nuclear geophysics apparatus are described. (Geophys. Abstr.)

28263 ATOMIC BEAM TUBE. (to Hewlett-Packard Co.). British Patent 1,112,234. May 1, 1968. Priority date Aug. 18, 1964, United States.

An atomic-beam frequency standard is described which utilizes a circular electric mode C-field resonator with a cylindrical construction which improves the frequency stability. (W.H.K.)

Radiation Effects on Instruments and Instrument Components

28264 EFFECTS PRODUCED BY FAST NEUTRON BOMBARDMENT OF Ge(Li) GAMMA RAY DETECTORS. Kraner, H. W.; Chasman, C.; Jones, K. W. (Brookhaven National Lab., Upton, N. Y.). Nucl. Instrum. Methods, 62: 173-83(June 15, 1968). (BNL-11904).

The effects of fast neutron bombardment on Ge(Li) gamma-ray detectors were investigated at neutron energies of 1.10, 5.75 and 16.49 MeV. Measurements were made of reverse leakage current, capacitance, rise-time, energy resolution, and pulse-height decrease as a function of neutron dose. A degradation of energy resolution was the most notable effect and occurred for each energy after approximately 10^{10} n/cm^2. Experiments with a collimated gamma-ray source show that the degradation in energy resolution is due primarily to hole trapping. Calculations were made of the total number of defects produced by the bombardment of 1.2×10^{11} n/cm^2 at 1.10 MeV and a value of 1.3×10^{13} defects/cm^3 is estimated. Some rougher estimates were made at the other energies. Procedures and results obtained in processing two detectors after irradiation are described. The detector irradiated at 16.49 MeV was restored by redrifting at ~30°C. (auth)

28265 RADIATION EFFECTS ON THERMOCOUPLES. Gilles, W. P. (Aerojet-General Corp., Sacramento, Calif.). Nucl. Appl., 4: 370-1(June 1968).

A critique on "Direct Radiation Effects on Thermocouples," in Nucl. Appl., 3: 718(1967) by J. H. Leonard and D. B. Hunkar is presented. Also, the author's rebuttal is included. (W.H.K.)

28266 USEFUL TECHNIQUES FOR ANALYZING CAPACITOR TRANSIENTS IN A RADIATION ENVIRONMENT. Cordwell, W. A. (International Business Machines Corp., Owego, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans, Nucl. Sci., NS-15: No. 2, 30-5(Apr. 1968).

Some useful techniques of evaluating the radiation-induced transient response of circuits employing capacitors by using transient circuit analysis programs are discussed. Analysis methods to relate the capacitor's radiation-induced current generator to the basic parameters, $\dot{D}(t)$, K_p, K_d, and τ_d, using existing circuit analysis programs are given. An expression relating the change in voltage resulting from an absorbed dose for an arbitrary burst shape is also derived. (auth)

28267 NEUTRON RADIATION DAMAGE IN SILICON TRANSISTORS. Goben, C. A. (Univ. of Missouri, Rolla); Smits, F. M.; Wirth, J. L. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: No. 2, 14-29(Apr. 1968).

In the investigation of base and collector current as a function of the emitter-to-base voltage, previous studies have shown that neutron-induced base current has components originating in the emitter space charge region as well as the neutral base region. This study shows that while the low injection level neutron-induced base current is dominated by the space charge component, the high injection behavior appears to be controlled by recombination in the neutral base region. Additional experiments performed in special tetrode transistors and van der Pauw-type samples indicate that changes in collector current are dominated by recombination in the neutral base, while changes in base doping and mobility have only a secondary effect. These conclusions are reached from experiments on transistors with a ring emitter, on tetrode-type test transistors, and on special Hall-effect devices, and by a detailed analysis of the emission crowding characteristics of a ring-dot geometry device. (auth)

28268 LOW-ENERGY PROTON DAMAGE EFFECTS IN SILICON SURFACE-BARRIER DETECTORS. Coleman, J. A. (National Bureau of Standards, Washington, D. C.); Love, D. P.; Trainor, J. H.; Williams, D. J. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: 482-90(Feb. 1968).

From 14th Nuclear Science Symposium, Los Angeles. See CONF-671026.

In order to predict the useful lifetime of semiconductor detectors which operate in the Earth's trapped radiation belts, the effects of damage by 50 keV, 200 keV, 600 keV and 1 MeV protons on silicon, surface-barrier, transmission detectors have been studied for fluences from 10^{10} to 10^{14} protons/cm^2. Detector current, noise and capacitance increased with fluence, with significant increases occurring after 10^{13} protons/cm^2. Bias-voltage-dependent multiple peaking was observed with Am-241 alpha particles. The effects of damage by protons with these low energies are significantly reduced in transmission detectors if the protons enter the rear, aluminum contact rather than the front, gold contact. (auth)

28269 IRRADIATION EFFECTS OF RADIOISOTOPES TO THE STARTING POTENTIAL OF THE MIXED GAS DISCHARGE TUBE. I. Chee, Chol Kon (Seoul National Univ.). J. Nucl. Sci. (Seoul), 7: No. 1, 145-8(Oct. 1967). (In Korean).

Techniques for minimizing the fluctuation of the starting potential of mixed gaseous discharge tubes by radiation of radioisotopes are discussed. The results of these experiments show that the fluctuation of the starting potential minimize up to one tenth by increasing the radiation intensity. (auth)(NSA of Japan)

28270 EFFECT OF ELECTRON BOMBARDMENT ON SOME PARAMETERS OF SILICON PHOTOELECTRIC DEVICES. Gorodetskii, S. M.; Grigoreva, G. M.; Kreinin, L. B.; Lazovskii, V. V.; Landsman, A. P.; Sominskii, M. S. (Inst. of Semiconductors, Leningrad. Moscow All-Union Scientific Research Inst. of Current Sources). Fiz. Tekh. Poluprov., 2: 110-12(Jan. 1968). (In Russian).

The results of an investigation on electron-produced defects in silicon photoelectric devices at 0.5 to 7 MeV were reported. On the basis of comparison of experimental data with the calculated energy path of the number of double displacements, conclusions were made on the determining effect of the number of displacements in one collision event on the recombination characteristics of the perforated Si. (tr-auth)

LIFE SCIENCES

Biochemistry, Physiology, and Molecular Biology

Refer also to abstracts 28407, 28433, 28460, 28538, 28539, 28555, 28611, 28612, 28621–28624, 28628–28630, 28646, 28650, 28667, 28670, 28673, 28699–28701, 28707, 28709, 28719, and 30421.

28271 (ANL–7278) BIOLOGICAL AND MEDICAL RESEARCH DIVISION ANNUAL REPORT, 1966. (Argonne National Lab., Ill.). Dec. 1966. Contract W-31-109-eng-38. 335p. Dep. CFSTI.

Separate abstracts were prepared for eleven sections of this report. An additional section is included on educational activities in collaboration with the office of college and university cooperation. A list of 123 publications is included. (H.L.W.)

28272 (ANL–7278, pp 185-218) STUDIES IN CELLULAR FINE STRUCTURE. (Argonne National Lab., Ill.).

TENDONS—determination of fibrillogenesis in regenerating, of guinea pigs, rats, and squirrels using electron microscopy
MEMBRANES—development of plasma and nuclear, in grasshopper spermatocytes, role of ribosomes in
PROTOZOA—Tetrahymena pyriformis, determination of DNA replication patterns in synchronized cells of; Paramecium bursaria, discharge of trichocysts by, effects of geranium extract on
CHLOROPHYLL—synthesis in plastids of Chlorella, effects of continuous and interrupted light on
ROTORS—design for use in Martz collection centrifuge
GLUTARALDEHYDE—use for tissue fixation for electron microscopy (H.L.W.)

28273 (ANL–7278, pp 219-49) BIOCHEMISTRY. (Argonne National Lab., Ill.).

METHIONINE—biosynthesis in Candida, Escherichia coli, and mutants of Saccharomyces, enzyme regulation of
SCHIZOMYCOTA—Propionibacterium sp., synthesis of propionate by; Propionibacterium pentosaceum, metabolism of erythritol by, carbon-14 tracer study of, synthesis of ribosomes by, control of
EUMYCOTA—yeasts, production of ghost cells of, effects of ribonuclease on
DEUTERIUM OXIDES—effects on formation of aconitate from isocitrate
AMINO ACIDS—radioisotope effects on ion exchange chromatography of, carbon-14 and tritium
TRITIUM—incorporation in bile pigments
HORMONES—chromatography of steroid, effects of carbon-14 and tritium on
RADIATION DETECTORS; SCINTILLATION—performance for dual isotope studies, computer programs for monitoring
RATS—metabolism of proteins in liver mitochondria of; distribution of enzymes in liver mitochondria of; content of histones in nuclei of liver cells in; content of lysosomes in liver of (H.L.W.)

28274 (ANL–7278, pp 250-82) BIOPHYSICS. (Argonne National Lab., Ill.).

CELLS—radiation effects on survival of hamster, in culture, effects of age in generation cycle on x; radiation effects on synthesis of DNA, proteins, and RNA in hamster, x; radioinduced small colony formation by hamster, effects of age on x; radiation effects on hamster, effects of hydroxyurea on x; radioinduced chromosome aberrations and division delay in hamster, x
MOLECULES—interactions of nucleotide, in solution
ACRIDINE—binding to DNA
MICE—determination of circadian rhythm of tryptophan-indoleacetate enzyme system from liver of; radiation effects on weight of testes of, RBE for fission neutron and x
SCHIZOMYCOTA—Escherichia coli, radioinduced inactivation of, protective effects of acridine dyes against uv
DEUTERIUM OXIDES—effects on sedimentation coefficient, thermal denaturation, and uv spectrum of DNA; effects on high resolution spectrum of adenine, cytosine, guanine, guanosine, and thymine; effects on NMR spectrum of acridine orange
NUCLEAR MAGNETIC RESONANCE—spectra of bovine serum albumine and ribonuclease
MOLECULAR STRUCTURE—determination for meso α, β-dibromosuccinic acid and proteins. (H.L.W.)

28275 (NYO–2147-13, pp 11-15) EFFECTS OF ^{90}Sr AND ^{90}Y ON EMBRYOLOGICAL DEVELOPMENT. Casarett, Alison; Coomes, Roger (New York State Veterinary Coll., Ithaca. Dept. of Physical Biology).

There are a few reports in the literature suggesting that relatively low doses of ^{90}Sr produce marked effects on reproductive function and embryological development. However, there has not been enough work to permit unequivocal conclusions. This study is an attempt to systematically investigate the effects of strontium-90 (and daughter yttrium-90) on early embryological development using improved techniques and sufficient numbers to clarify the question. This is a new line of work in the program. So far there has been concentration on the development of some of the needed techniques for incorporation of the radionuclides into sperm and for in vitro embryo culture. (auth)

28276 (NYO–2147-13, pp 16-22) STRONTIUM RETENTION IN VARIOUS PARTS OF THE DOG SKELETON. Craig, P. H. (New York State Veterinary Coll., Ithaca. Dept. of Physical Biology).

Body burdens of bone seeking radionuclides are associated with the formation of tumors of the skull in both animals and man. Cancers of the mastoid (man) and external ear canal (rabbits) suggest that such nuclides may localize in ear bones preferentially. A pilot study was started, using dogs, to determine the extent to which ear bones can incorporate radiostrontium rapidly and release it slowly, as compared to other bones. Such behavior was reported in rabbits, and a critical factor appears to be the age at time of exposure to the nuclide. Techniques were worked out for whole body counting, autoradiography, and bone specimen analyses in connection with special problems that arise in this type of study. (auth)

28277 (NYO–2147-13, pp 23-7) REDUCTION OF RADIOSTRONTIUM IN COW'S MILK WITH SODIUM ALGINATE. Wentworth, R. A.; Comar, C. L.; Anderson, J. J. (New York State Veterinary Coll., Ithaca. Dept. of Physical Biology).

It is known that sodium alginate reduces the gastrointestinal absorption of strontium compared to calcium in human beings and rats. The preliminary studies reported here indicate that about a two-fold reduction in $OR_{milk/diet}$ can be accomplished by feeding these materials to lactating cows. The physical properties of the alginates are important as far as practical feeding practice is concerned. Other factors to be considered include the acid composition and simultaneous use of other conditions that are known to reduce the $OR_{milk/diet}$ values. (auth)

28278 (NYO–2147-13, pp 53-5) STUDIES ON THE SECRETION OF IODIDE INTO THE MILK OF THYROIDECTOMIZED GOATS. Lengemann, F. W. (New York State Veterinary Coll., Ithaca. Dept. of Physical Biology).

L-thyroxine administered to normal lactating cows decreases milk ^{131}I concentration by decreasing the milk-plasma iodide ratio. To determine if the effect of the thyroxine is directly on mammary tissue or indirectly through its effect upon thyroid stimulating hormone output by the pituitary, a study was carried out using thyroidectomized lactating goats given various combinations of L-thyroxine and/or thyroid stimulating hormone. The results indicated that the withdrawal of thyroid stimulating hormone could lower the milk-plasma iodide ratio. (auth)

28279 (NYO–2147-13, pp 56-7) EFFECT OF AGE ON THE RETENTION OF CESIUM BY RATS. Lengemann, F. W. (New York State Veterinary Coll., Ithaca. Dept. of Physical Biology).

The retentions of repeated single doses of radiocesium were followed over the lifetimes of 30 male albino rats. These studies showed that the turnover time of ^{134}Cs was shortest in the youngest animals and then increased markedly with age until the animals were about four months old. After this time increases were still observed but were of much less magnitude. Resolution of the retention curves into three compartments showed that the last compartment increased markedly in size up to about four months of age; small increases were noted thereafter. (auth)

28280 (NYO–2147-13, pp 58-63) RETENTION OF CESIUM AS AFFECTED BY WEANING. Lengemann, F. W. (New York State Veterinary Coll., Ithaca. Dept. of Physical Biology).

In these experiments rat pups were given I.P. injections of ^{134}Cs at four days of age and the retention of the radiocesium followed. It was noted that up to the time of weaning, the pups lost half of

the radiocesium every 10.9 days. After weaning the rate of loss increased markedly and became a multiexponential rate of loss rather than the single exponential loss rate during nursing. Experimental procedures definitely ruled out recycling of radiocesium through the dams and the physical nature of the diet after weaning as being contributory factors to the observed changes in cesium retention. (auth)

28281 (NYO–2147-13, pp 72-7) INTESTINAL ABSORPTION OF OLEIC ACID ^{131}I AND TRIOLEIN ^{131}I IN THE DIFFERENTIAL DIAGNOSIS OF MALABSORPTION SYNDROME AND PANCREATIC DYSFUNCTION IN THE DOG. Kallfelz, Francis A. (New York State Veterinary Coll., Ithaca. Dept. of Physical Biology).

The use of oleic acid ^{131}I and triolein ^{131}I appears to be a useful diagnostic tool in the diagnosis of pancreatic dysfunction and malabsorption syndrome in the dog. After oral administration of either drug in capsular form, the amount of absorption can be determined by counting the feces or counting periodic blood samples and correcting for the amount present in the entire blood stream. In normal dogs an average maximum of 13.0% of a dose of oleic acid ^{131}I and 11.0% of triolein ^{131}I was absorbed. In dogs affected with pancreatic insufficiency, the absorption of oleic acid ^{131}I was normal while the absorption of triolein was below 2%. In one dog showing both pancreatic and intestinal pathology, the absorption of both substances was below the average. (auth)

28282 (NYO–2147-13, pp 182-92) X-RAY DETECTION: INTERCHANGEABILITY OF OZONE AND X-RAY AS CONDITIONAL STIMULI. Gasteiger, Edgar L.; Helling, Sharon A. (New York State Veterinary Coll., Ithaca. Dept. of Physical Biology).

To determine the possible role of ozone as mediator in x-ray detection, rats were conditioned to stop licking upon presentation of the odorants ozone or ethyl butyrate (pineapple odor). Under identical test conditions, x irradiation for 10 sec was then substituted for the odors. Rats conditioned to ozone readily transferred their conditional behavior to x irradiation while those conditioned to ethyl butyrate did not. A reverse testing situation in which animals were first conditioned to the x-ray exposure and then presented with either ozone or ethyl butyrate gave additional support to the similarity of ozone and x ray. (auth)

28283 (ORNL–4100, pp 75-96) CELL GROWTH AND DIFFERENTIATION. (Oak Ridge National Lab., Tenn.).

CELLS—generation time of amphibian lens, incorporation of tritium-labeled leucine and uridine in amphibian lens; uptake of tritium-labeled thymidine by lens, of chick embryo; content of RNA in ribosomes of lens; synthesis of RNA in lens epithelial, effects of actinomycin D on; distribution of crystalline in bovine lens; analysis of pulse-labeled RNA in bovine lens; synthesis and subunit structure of crystalline in bovine lens; synthesis of lens proteins in cultured epithelial; development of lens, in eyes of chick embryos, DNA synthesis during; purity of γ-crystallins in lens, of eyes of frog embryos; synthesis of RNA in regenerating, in lens of Triturus

OOCYTES—metabolism of RNA in nucleoli of, in Triturus; isolation of nuclei from, of Rana pipiens; development of yolk in, of Limulus polyphemus; separation of lipoproteins from, of blue crabs

EGGS—isolation of lipoproteins from crustacean; content of yolk proteins in, of teleost fish

SPERM—determination of centriole adjunct in, of wasps (E.R.B.)

28284 (ORNL–4100, pp 127-34) PATHOLOGY AND PHYSIOLOGY. (Oak Ridge National Lab., Tenn.).

MICE—radiation effects on life span of laboratory; radioinduced leukemia and lymphomas in; radioinduced leukemia in, effects of microbial environment on; leukemia induced in germ free, by methyl cholanthrene, benzene, or croton oil; use of germ free, to monitor microbiological environment

RATS—development and distribution of megakaryocytes in bone marrow of, effects of DNA content on

VIRUSES—effects on production of mucopolysaccharides in myxofibrosarcomas; leukemia, effects on esterase zymograms (E.R.B.)

28285 (ORNL–4100, pp 135-40) PLANT PHYSIOLOGY AND PHOTOSYNTHESIS. (Oak Ridge National Lab., Tenn.).

GAMMA RADIATION—effects on growth of wheat seedlings, effects of seed and seedling exposure on; effects on leaf tissues of wheat, effects of dose on lethal; effects on chloroplast ultrastructure in wheat, effects of light on; effects on growth of root cells in wheat, tritium tracer study of

EMZYMES—activation of electron transport, in relation to energy storage in chloroplasts of angiosperms

CHLOROPHYTO—photosynthesis in, effects of light and oxygen on

BETA PARTICLES—effects on fluorescence of chlorophyll (E.R.B.)

28286 (ORNL–4100, pp 153-9) ENZYMOLOGY. (Oak Ridge National Lab., Tenn.).

EUMYCOTA—Neurospora crassa, synthesis of RNA in cytoplasm and mitochondria of; Neurospora crassa, production for biochemical research methods for; Neurospora crassa, isolation of mitochondria from, use of ultracentrifuge for

SCHIZOMYCOTA—Escherichia coli, production for biochemical research, methods for; Escherichia coli, binding of RNA nucleotidyltransferase to polyribosomes of; Escherichia coli, activity of polyribosomes in; Escherichia coli, isolation of phenylalamyl-RNA synthetase from; Escherichia coli, production of polyribosomes by mutants of, effects of actidione on; Escherichia coli, incorporation of amino acids in polyribosomes of

ANTIBODIES—production in blood of rabbits, iodine-125 tracer study of; production in rats, effects of RNA synthesis on

NUCLEIC ACIDS, RIBO—species of, effects of, on protein synthesis; reactions with phenylalanine, effects of methylation on; molecular structure of, use of optical rotary dispersion to determine; reactions with phenylalanine RNA synthetase from Neurospora, fluorescence following

ALCOHOL DEHYDROGENASE—absorption of DEAE-cellulose

ISOENZYMES—activity of, genetic control of (E.R.B.)

28287 (ORNL–4100, pp 160-4) BIOCHEMICAL REGULATION. (Oak Ridge National Lab., Tenn.).

TYROSINE AMINOTRANSFERASE—synthesis in perfused liver of rats, effects of glucagon, growth hormone, and insulin on; degradation of, effects of actinomycin D and cycloheximide on; synthesis in pathogen-free rats, effects of growth hormone on

RATS—content of polyribosomes in liver of fetal; synthesis of RNA in liver of fetal, effects of insulin on (E.R.B.)

28288 (ORNL–4100, pp 166-77) BIOPHYSICS. (Oak Ridge National Lab., Tenn.).

ULTRAVIOLET RADIATION—induced thymine dimers in bacterial DNA; effects on transforming ability of DNA in Hemophilus influenzae; effects on germination and survival of spores of Bacillus megaterium and B. subtilus in relation to photoproducts; effects on tryptophanase activity in Escherichia coli, effects of temperature on photoreactivation of; effects on respiration of Escherichia coli; effects on molecular structure of DNA in Escherichia coli; induced thymine dimers in DNA from yeast, effects of enzymes and light on photoreactivation of; effects on excision of pyrimidine dimers from DNA by bacterial extracts; effects on DNA from Gecareinus lateralis

NUCLEIC ACID, DEOXYRIBO—content of satellite, in Crustacea; content of adenine and thymine in satellite, of Crustacea; content of chromosomes in Physarum polycephalum; radiolysis of bacterial, repair of X,

LEAVES—bacterial contamination in plastids of corn, effects of centrifugation on; content of RNA in plastids of corn

BACTERIOPHAGES—repressors of, effects of temperature on activity of

NUCLEI (CELLS)—sedimentation of slime mold, use of alkaline sucrose gradient centrifugation for

LIVER—distribution of photoreactivating enzymes in, of frogs

TISSUES—radiation dose to, effects of elemental composition on specifications for ionizing (E.R.B.)

28289 (ORNL–4100, pp 178-201) COOPERATIVE PROGRAMS: AEC–NIH CHEMICAL CARCINOGENESIS. (Oak Ridge National Lab., Tenn.).

TYROSINE AMINO TRANSFERASE—synthesis in cultured liver cells from fetal rats, effects of hydrocortisone on; synthesis in regenerating liver of rats, effects of adrenalectomy, partial hepatectomy and hydrocortisone on; synthesis in cultured hepatoma cells, effects of cortisone and insulin on

VIRUSES—Shope papilloma, effects on synthesis of lipoproteins in rabbits; Shope papilloma, effects on arginase activity in papillomas, mutant; TMV, incorporation of RNA in; TMV, effects on content of phenylalamine and RNA in tobacco leaves

MICE—activation of aminoacids in plasma cell tumors of; physiology of LM-induced tumor cells of; radiation effects on incidence of lymphomas and on life span of, combined effects of triethylene melamine on x; leukemia incidence in thymus gland of, combined effects of croton oil and methyl cholanthrene on; synthesis of hemagglutinin in, in response to test antigen, effects of age and splenectomy on; radiation effects on spleen cells of, effects of antigen on recovery from X; localization of antigens in lymphatic tissues of spleen in

SCHIZOMYCOTA—Escherichia coli, content of proteins in, combined effects of benzopyrene and light on; Escherichia

coli, synthesis of leucine-containing RNA in phage-infected; Escherichia coli, synthesis of proteins in phage-infected, effects of chloramphenicol on; Escherichia coli, synthesis of DNA in phage-infected, effects of fluorodeoxyuridine on
CELLS—content of RNA in liver, of rats, effects of ethionine on; selection of genetic variants in cultured mammalian; radiation effects on cultured mammalian, mutagenic uv and x; mutations induced in cultured mammalian, by nitrosoguanidine and triethylene melamine; effects of aminopterin and hydroxyurea on cultured mammalian; content of aminoacyl-containing RNA in normal and virus-infected mammalian
TYROSINE—components in bovine serum albumin in relation to luminescence; components of ribonuclease in relation to luminescence; components of ribonuclease, reactions of, with ATP
DISEASES, NEOPLASTIC—carcinomas, induced in liver of rats by ethionine; carcinomas, induced in rodents by diethylnitrosoamines; carcinomas, induced by ethylating compounds in relation to their mutagenic properties
ANIMALS—incidence of chromic acid dust-induced diseases in laboratory, from chronic exposure to chromic oxide dust; core of laboratory, used in inhalation chamber experiments
X-RAY DIFFRACTION ANALYSIS—performance for determination of structure of thymine dimers, use of computer for data analysis
MUTATIONS—induced in Drosophila and microorganisms by nitrosoamines
PROTEINS—incorporation of heavy atoms in
RNA PYROPHOSPHORYLASE—methods for purification of
AMINO ACIDS—system for incorporation of, isolation of products formed by (E.R.B.)

28290 (YALE-2653-29) THE EFFECTS OF RADIATION ON BIOLOGICAL MOLECULES. Progress Report, July 1, 1966–July 1, 1967. Hutchinson, F. (Yale Univ., New Haven. Dept. of Molecular Biophysics). July 1, 1967. Contract AT(30-1)-2653. 4p. Dep. CFSTI.

Double stranded breaks in DNA of bacterial cells were produced by ionizing radiation. Strands of DNA were removed from Bacillus subtillis by a dialysis technique using sodium dodecyl sulfate and pronase. Effects of gamma radiation on sedimentation of DNA were studied, and a graph is presented to show variations with increasing doses. Healing of radioinduced single strand breaks in DNA was determined using the technique of sedimenting in alkali and the healing of double strand breaks by sedimenting the double helical molecule at neutral pH. (H.L.W.)

28291 EFFECT OF SYNTHETIC AND NATURAL INHIBITORS OF LIPID OXIDATION ON OLEIC ACID (RADIOMIMETIC) HEMOLYSIS. Kakushkina, M. L.; Kudryashov, Yu. B.; Filenko, O. F. Tr. Mosk. Obshchest. Isptyt. Prir., Otd. Biol., 16: 91-4 (1966). (In Russian).

From Symposium on Free Radicals Processes in Biological Systems, Moscow. See CONF-640635.

Radiation injuries may be reduced by chemical compounds produced in irradiated animal tissues. The erythrogram method was used for studying antioxidants. Phospholipids and free radical inhibitors such as propyl gallate and AET were effective in preventing hemolysis. The inhibitory effect was reduced by a mixture of phospholipids and cysteamine.

28292 MORE PROBABLE RADICALS STATES IN NUCLEIC ACID CHAIN IN PROCESS OF AQUA SOLUTION RADIATION. Shal'nov, M. I.; Krushinskaya, N. P. Tr. Mosk. Obshchest. Isptyt. Prir., Otd. Biol., 16: 99-105(1966). (In Russian).

From Symposium on Free Radicals Processes in Biological Systems, Moscow. See CONF-640635.

The EPR method was used to determine the concentration of paramagnetic centers in irradiated DNA, but could not be used to determine their localization. Indirect, but objective estimation of more probable radical states in DNA chains can be made by means of radiolysis of its nucleotide products. According to radiochemical estimation approximately 75% of radicals, generating in DNA chain are connected with its decoding (i.e., loss or change of grounds) and 25% with the depolymerization (i.e., individual or double ruptures of chains because of desoxyribose injury). The radicals discovered after radiation may be intermediate degradation products of hydroperoxide and carbonyl. The rate of their destruction depends on oxygen, temperature and pH conditions. Long conservation of uncoupled electrons appears to be less probable than constant production of shortlived paramagnetic centers as a result of destruction of radiolysis-labile products in polynucleotide chains. (auth)

28293 SVODODNORADIKAL'NYE PROTSESSY V BIOLOGICHESKIKH SISTEMAKH. (Free-Radicals Processes in Biological Systems). Zhuravlev, A. I. (ed.). Transactions of the Moscow Society of Naturalists, Vol. XVI, Biological Series, Section of Biophysics and Radiobiology. Moscow, Izdatel'stvo Nauka, 1966. 293p. (CONF-640635).

Separate abstracts were prepared for 24 chapters of this book. Thirty-eight additional chapters on the role of free radicals in biological and chemical processes are included. (H.L.W.)

For abstracts of individual chapters see: 28291, 28292, 28294–28303, 28363–28372, 28548, and 28707.

28294 FLOWING INSTALLATION FOR STUDYING THE PROCESSES OF AFTER-LUMINESCENCE OF IRRADIATED SOLUTIONS OF ALBUMEN, AMINO ACIDS, DYES, AND SYNTHETIC POLYMERES. Sapezhinskii, I. I. Tr. Mosk. Obshchest. Isptyt. Prir., Otd. Biol., 16: 25-7(1966). (In Russian).

From Symposium on Free Radicals Processes in Biological Systems, Moscow. See CONF-640635.

A description was made of the variants of a simple flowing installation for studying the process of after-luminescence of various solutions irradiated with ultraviolet and x rays. The kinetic curves of the afterluminescence of some substances are presented. (auth)

28295 IDENTIFICATION OF FREE RADICALS STATES IN IRRADIATED BIOLOGICAL SYSTEMS BY MEANS OF INOCULATED COPOLYMERIZATION TECHNIQUE. Kozlov, Yu. P.; Tarusov, B. N. Tr. Mosk. Obshchest. Isptyt. Prir., Otd. Biol., 16: 31-5(1966). (In Russian).

From Symposium on Free Radicals Processes in Biological Systems, Moscow. See CONF-640635.

A technique of identification of free radicals induced by ionizing radiation in biological systems by means of polymerization of water-soluble monomers of the vinyl group was developed. Synthetic polymers were successfully inoculated to normally metabolizing plant and animal tissues and also to model systems. Optimum conditions of the processes of copolymerization, that depend on the type of the monomer and biological and model systems, were defined. The appearance of inoculated systems provided a complex of analytic, physico-chemical and physical techniques (measurement of molecular weights of inoculated components by means of viscosimetric, dilatometric and sedimentary techniques, autoradiography, chemiluminescence and electronic paramagnetic resonance techniques, biological functions changes complex, and comparison of the systems behaviors when monomers are changed for their hydrogenated derivatives). (auth)

28296 STUDY OF RADICAL PROCESSES IN ANIMAL TISSUES UNDER X-RAY IRRADIATION BY MEANS OF POLYMERIZATION TECHNIQUE. Tarusov, B. N.; Kozlov, Yu. P.; Limarenko, I. M.; Bao-Shen, Se. Tr. Mosk. Obshchest. Isptyt. Prir., Otd. Biol., 16: 44-6(1966). (In Russian).

From Symposium on Free Radicals Processes in Biological Systems, Moscow. See CONF-640635.

The process of the formation of free radicals in various tissues of tadpoles after x-irradiation was studied. It was shown that at the inoculation of monomer of acrylamide in the irradiated tissues its polymerization due to the appearance of free radicals takes place. The acrylamides' carbon index tested by the radioactive isotope ^{14}C permitted location of free radicals in tissues by means of histoautoradiography. By this method the time kinetics of radical processes was studied. (auth)

28297 RADICAL POLYMERISATION OF ACRYLAMIDE IN IRRADIATED HOMOGENATES OF RATS' TISSUE. Tarusov, B. N.; Kozlov, Yu. P.; Urtile, S. Tr. Mosk. Obshchest. Isptyt. Prir., Otd. Biol., 16: 47-9(1966). (In Russian).

From Symposium on Free Radicals Processes in Biological Systems, Moscow. See CONF-640635.

It was shown that under γ irradiation of rats' tissue homogenates there appear free radical states of native macromolecules that can initiate polymerization of the acrylamide inoculated into cells. In this case the process of polymerization of acrylamide generally takes place in the lipid part of the lipoprotein complex of the cells. (auth)

28298 EFFECT PRODUCED BY VARIOUS RADIOPROTECTIVE SUBSTANCES ON THE PROCESS OF THE LONG AFTER-LUMINESCENCE OF ALBUMEN SOLUTIONS IRRADIATED WITH ULTRA-VIOLET LIGHT. Sapezhinskii, I. I.; Silaev, Yu. V. Tr. Mosk. Obshchest. Isptyt. Prir., Otd. Biol., 16: 54-6(1966). (In Russian).

From Symposium on Free Radicals Processes in Biological Systems, Moscow. See CONF-640635.

The effect of 13 different substances (radioprotective included) on the nature of the long after-luminescence of serum albumen solutions irradiated with ultraviolet light was studied. The experiment showed that the most active radioprotective agents strongly affect the after-luminescence kinetics. (auth)

28299 PROBLEM OF THE HIGH-TEMPERATURE RECOMBINATION LUMINESCENCE OF γ-IRRADIATED AMINO ACIDS. Mochalkin, A. I. Tr. Mosk. Obshchest. Isptyt. Prir., Otd. Biol., 16: 57-8(1966). (In Russian).

From Symposium on Free Radicals Processes in Biological Systems, Moscow. See CONF-640635.

A thermoluminescence of both irradiated and nonirradiated amino acids was observed. The suggestion was made that these experimental data permit estimation of the depth of the traps in biomolecules. (auth)

28300 CHEMILUMINESCENCE AS A RESULT OF INFLUENCE OF FREE RADICALS ON NORMAL AND IRRADIATED YEAST CELLS. Petrusevich, Yu. M.; Konoplyannikov, A. G. Tr. Mosk. Obshchest. Isptyt. Prir., Otd. Biol., 16: 59-61(1966). (In Russian).

From Symposium on Free Radicals Processes in Biological Systems, Moscow. See CONF-640635.

Chemiluminescence in the blue-green region of spectrum can be seen when yeast cells Saccharomyces vini are attacked by free radicals. It was supposed that chemiluminescence takes place when the lipids of cell membrane are oxidized with radicals. Sharp rise of cell chemiluminescence intensity is observed when they are attacked by free radicals occurring every 30 to 60 min after ^{60}Co γ irradiation of cells. (auth)

28301 FREE-RADICAL MECHANISM OF THE PROTECTIVE ACTION OF SOME NATURAL COMPOUNDS. Tkhor, L. F.; Taranenko, G. A.; Kozlov, Yu. P. Tr. Mosk. Obshchest. Isptyt. Prir., Otd. Biol., 16: 73-6(1966). (In Russian).

From Symposium on Free Radicals Processes in Biological Systems, Moscow. See CONF-640635.

With the use of techniques of electron paramagnetic resonance and chemiluminescence, it was shown that plant tissues of the aralia group contain some natural components with a substantial concentration of free radicals. It was found that such components may be represented by glucosides that seem to play an important role in regulation of free-radical reactions in organisms irradiated with ionizing radiation. (auth)

28302 ARISING OF LONG CHEMILUMINESCENCE AS A RESULT OF IRRADIATION OF PROTEIN SOLUTIONS AND DRY PROTEINS WITH X RAY AND γ RAY. Sapezhinskii, I. I.; Silaev, Yu. V. Tr. Mosk. Obshchest. Isptyt. Prir., Otd. Biol., 16: 78-80 (1966). (In Russian).

From Symposium on Free Radicals Processes in Biological Systems, Moscow. See CONF-640635.

Some kinetic regularities of chemiluminescence arising under influence of oxygen on irradiated protein were studied. It was shown that kinetic curves of radical decrease obtained by means of the EPR method are analogous with kinetic curves of luminescence. The effect of long postluminescence of polymer solutions and protein solutions irradiated with x rays in small (1 to 5 kRad) doses was discovered. The dependences of luminescence intensity on temperature, dose, and concentration were studied. Cysteine and propylgallate decrease postluminescence intensity. Some suggestions on the nature of postluminescence action are made. (auth)

28303 NATIVE RADIOMIMETIC AND PRIMARY RADICALS GENERATED IN IRRADIATED LIPIDS. Kudryashov, Yu. B.; Baltbarzdys, Z.; Mekhtieva, S.; Le Dak Lyeu. Tr. Mosk. Obshchest. Isptyt. Prir., Otd. Biol., 16: 87-90(1966). (In Russian).

From Symposium on Free Radicals Processes in Biological Systems, Moscow. See CONF-640635.

It was shown that β-carotene dissolved in oleic acid possesses a high radiosensitivity. The carotene radiosensitivity depends on the generation of peroxide products (radicals) in oleic acid. The oxygen effect experiment was described, and the kinetic curves of the radiolysis effect dependent on the dose and time expired after the irradiation are under examination. A chemical model estimating the antioxidating and antiradical activity of radioprotectors, aminothiols and vitamins, was developed. A conception of the relations of the appearance of primary radicals, generated in lipids, with the natural radiomimetic and their chemical nature was suggested. (auth)

28304 REPARTITION OF NATURAL ^{14}C LEVELS IN VARIOUS CONSTITUENTS OF THE BIOPHASE OF A SUPERFICIAL SEDIMENT OF THE WEST MEDITERRANEAN. Thommeret, Jean; Thommeret, Yolande (Centre Scientifique, Monaco). Cah. Oceanogr., 19: 495-504(June 1967). (In French).

The rate of accumulation of sediments on the continental shelf of the Ligurian Sea should be measurable by means of the difference in ^{14}C content of the different organogenic layers of the sediment. Samples were taken by hand-coring from a superficial slimy bottom at 110-m depth, 350 m south of Cape Ferrat (Alpes-Maritimes). Superficial sediments were found to be heterogeneous; different types of calcareous biocoenoses could easily be extracted from them. Different types of biogenic carbonates presented variable ages in the same layer. Ages of different sieved fractions in the same layer did not agree; variation did not always increase depth. Near the surface, dating of disturbed sediments should be avoided. At a distance from the surface, dated fauna should be studied to ensure remaining within a specific geological period; otherwise it would be quite possible to obtain inversion of the ^{14}C level because of different isotopic compositions of various fauna at the time of the sedimentation. (BBB)

28305 RADIOACTIVITY IN THE INDIVIDUAL: FACTORS AFFECTING THE UPTAKE AND RETENTION OF BONE-SEEKING RADIONUCLIDES. Rivera, Joseph (Health and Safety Lab., New York). Pediatrics, 41: Suppl., 231-9(Jan. 1968).

A model used to fit the data which takes into account changes in the ^{90}Sr content of the skeleton due to remodeling and to bone growth is presented and is expressed in an equation. Results of the Tri-City diet ^{90}Sr content studies are shown which indicate that the highest ^{90}Sr intakes have been in New York City, the lowest in San Francisco, and intermediate in Chicago. Intakes at all three cities sharply increased early in 1963 and attained new plateaus in 1964, at levels roughly three times as high as those during 1960, 1961, and 1962. Average ^{90}Sr concentrations in human vertebrae obtained in New York City, Chicago, and San Francisco from March 1961 through 1964 are also listed. It was found that the adult ^{90}Sr bone data were reasonably described by the above mentioned. To investigate the possible similarities that may exist between Sr metabolism and that of other alkaline earths such as ^{226}Ra, diet and bone samples were assayed for ^{226}Ra. It was found that, as with ^{90}Sr metabolism, there appeared to be diminished discrimination between ^{226}Ra and Ca in the passage of these nuclides from the diet to bone during infancy as compared to adulthood. To improve the accuracy of inferences of some metabolic factors in the equation that were needed to calculate doses from ^{90}Sr or other bone-seeking radionuclides from survey data, certain additional information was needed. For example, it was necessary to know the fraction of urban dwelling infants that were breast fed, and the duration of this feeding. The ratio of active bone marrow to skeleton at various ages must also be known to calculate radiation doses. (BBB)

28306 THE EFFECT OF HEATING AND γ-IRRADIATION ON THE ENZYME ACTION SUSCEPTIBILITY OF EGG WHITE PROTEINS. Kurokawa, Kazuo (Tokyo Metropolitan Kakuo Senior High School). Eiyo To Shokuryo, 18: 29-31(1965). (In Japanese).

Heat-coagulated egg white proteins were digested at 37°C for 30 min by pepsin and trypsin. Susceptibility of egg white proteins to pepsin was not affected by heating of proteins, while that to trypsin was increased with increasing temperature of the heat treatment. When egg white proteins were heated and then irradiated with ^{60}Co γ rays, no dose effect was found with respect to their susceptibility to pepsin and trypsin. Doses of 0.8 to 5 × 10^5 Rad were given. In the case of posttreatment by heating, there was no temperature effect on the susceptibility to pepsin action. Considerable combined effects of irradiation and post heating on the susceptibility to trypsin were observed. (BBB)

28307 ^{90}Sr IN TEETH: REPORT OF CONTINUED INVESTIGATION. Lindemann, J. (Koebenhavns Tandlaegehoejskole, Copenhagen). Tandlaegebladet, 71: 731-9(1967). (In Danish).

Measurements of ^{90}Sr were made in crowns and roots separately from pooled deciduous canines, deciduous first and second molars, crowns and roots separately from pooled permanent first molars, and crowns and roots separately from pooled first and second premolars. The teeth were extracted in the fall of 1963 and the fall of 1964 from children born in the years 1950 to 1956. In addition, ^{90}Sr activity was measured in crowns and roots separately from pooled permanent teeth of individuals born in the years 1925 to 1935, extracted in the spring of 1965 and the spring of 1966. No significant reflection of the relatively heavy ^{90}Sr fallout during 1963 and 1964 was observed in the ^{90}Sr activity in crowns and roots of adults born in 1925 to 1935. The amount of ^{90}Sr activity was controlled by the ^{90}Sr level during mineralization of crowns and roots. In periods of increasing ^{90}Sr environmental levels, crowns and roots of former fully developed deciduous teeth contained essentially more ^{90}Sr than crowns and roots of permanent teeth when tooth mineralization of the respective teeth was finished at the same time. This phenomenon was thought to be related to resorption processes going on in deciduous teeth. It was suggested that ^{90}Sr was possibly not resorbed at the same time as Ca, or that resorbed ^{90}Sr was reincorporated by unresorbed hard tooth tissues. This, together with the possibility that unresorbed hard tooth tissues in the teeth undergoing resorption were subject to a continued supply of ^{90}Sr, could explain the increased amount of ^{90}Sr per g of Ca in this period. The highest activity of ^{90}Sr in groups of teeth extracted during the fall 1964 was found in roots

of pooled first and second premolars from children born in 1954 (2.9 pCi/g Ca). (BBB)

28308 ACETOACETATE DECARBOXYLASE. CATALYSIS OF HYDROGEN–DEUTERIUM EXCHANGE IN ACETONE. Tagaki, Waichiro; Westheimer, F. H. (Harvard Univ., Cambridge, Mass.). Biochemistry, 7: 901-5(Mar. 1968).

The mechanism for the decarboxylation of acetoacetic acid by acetoacetate decarboxylase proceeds by way of the enamine of acetone. The reverse reaction should then lead from acetone to this enamine, and therefore the mechanism required that the enzyme catalyze the exchange of hydrogen atoms between acetone and solvent. This prediction was realized; the rate of the reaction was measured by nuclear magnetic resonance techniques. The interconversion of enamine and Schiff base salt was so rapid, compared to that for chemical analogs, that this step in the mechanism had to be enzymic. (auth)

28309 THE EFFECT OF pH UPON THE NUCLEAR MAGNETIC RESONANCE SPECTRA OF NUCLEOSIDES AND NUCLEOTIDES. Danyluk, S. S.; Hruska, F. E. (Argonne National Lab., Ill.). Biochemistry, 7: 1038-43(Mar. 1968).

The pD dependence of the proton chemical shifts of a number of purine and pyrimidine bases, their nucleosides and nucleotides was studied in D_2O at 32°. It was concluded from the nuclear magnetic resonance results that a weak ring–chain interaction of an electrostatic type was operative in both the 5′-purine and pyrimidine nucleotides over the pD range of 1 to 8.2. No interaction of this type was indicated for the isomeric 2′- and 3′-nucleotides. The present results were consistent with a preferred anti conformation for 5′-nucleotides in solution and also indicated that the presence of a possible hydrogen bond between the 2′-OH group and the N-3 position in purine nucleotides had little effect upon the ring–chain interaction. (auth)

28310 EXCHANGE OF FAST-LABELED RNA IN HeLa CELLS, SYNCHRONIZED BY γ IRRADIATION TO S PERIOD. Kalendo, G. S.; Kuzin, A. M. (Inst. of Physical Biology, Moscow). Dokl. Akad. Nauk SSSR, 178: 461-4(Jan. 11, 1968). (In Russian).

The rate of exchange of fast-labeled RNA at the highest point of synchronization (up to 75 to 80%) during γ irradiation and cell transition from one phase to another was studied. Experiments with cultured HeLa cells irradiated with 10 cR doses, at room temperature showed that the highest synchronization point to S period (reaching to 75%) drops 10 to 14 hr following the exposure. Examination of the number of cells in S period as a function of the time following the irradiation, the initial rate of ^{3}H-uridine inclusion into RNA nucleus, and the changes in relative rate of RNA synthesis as a function of the time after the exposure indicated that the process of synthesis of fast labeled nuclear RNA exhibits sufficiently strong resistance to ionizing radiation. (R.V.J.)

28311 MEASUREMENT OF THE K ISOTOPE DISTRIBUTION IN HUMAN AND ANIMAL CELLS FOR THE STUDY OF THE ACTIVE TRANSPORT. Zimmermann, U.; Wagener, K. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Z. Naturforsch., 22b: 707-9(July 1967). (In German).

The mass spectrometric measurement of the isotope ratio $^{39}K/^{41}K$ in cell water and extracellular fluid in human and chicken blood and also in F1 cells showed no displacement in the isotopic ratio. The limits of error were ±0.35%. The large variation in Ca concentration between the two phases is of significance in the clarification of the active transport mechanism. (tr-auth)

28312 BEHAVIOR OF MUCOPROTEINS IN PANIRRADIATED RABBITS. Ragaglini, G.; Fanciulli, S.; Mengaldo, R. Radiaz. Alta Energ., 6: 209-27(Oct. 1967). (In Italian).

The behavior of the neuraminic acid and of the mucoproteins of the blood serum in a pan-x-irradiated rabbit was followed. The impossibility of comparing the variations of the neuraminic acid with those of the mucoproteins by superposition leads to the supposition that the metabolism of the first takes place, at least partly, independent from the metabolism of the second. This is due to radiation effects on the basic substance of the connective elements, on the protein synthesis, on the removal of glycoproteins from circulation in consequence of homoeostatic phenomena, and on the setting in motion of the enzymatic systems responsible for such metabolisms. It was emphasized that only in the case of the neuraminic acid, the radiation effects appear to exter a stable and definitive influence on it. (auth)

28313 DISTRIBUTION VOLUMES IN THE DOG KIDNEY DURING ANURIA PRODUCED BY URANIUM NITRATE. Eisner, Gilbert M.; Slotkoff, Lawrence M.; Lilienfield, Lawrence S. (Georgetown Univ., Washington, D. C.). Amer. J. Physiol., 214: 929-34(Apr. 1968).

Distribution volumes of T-1824, inulin, and sodium were compared in the kidneys of 11 dogs during free flow and stop flow, and in another 6 dogs anuric as a result of tubular necrosis produced by uranium nitrate. The tracers were injected into the aorta at the level of the renal artery and the renal venous outflow was collected to determine mean transit time. The mean transit time of each tracer multiplied by the renal plasma flow yielded the distribution volume. Sodium-22 sodium chloride was used to study the distribution of the sodium ion. In the normal kidney during free flow the distribution volume of sodium was greater than that of inulin which in turn was greater than that of T-1824. Results during stop flow were nearly identical. During anuria the distribution volume of inulin was greater than in the normal kidney and nearly identical to the distribution volume of sodium. The results indicate that in the kidneys with necrosis produced by uranium nitrate, inulin has access to and egress from an intraluminal compartment. (auth)

28314 AN AUTORADIOGRAPHIC STUDY OF CHRONOLOGICAL EFFECTS OF NUCLEOLUS IRRADIATION WITH AN ULTRAVIOLET MICROBEAM ON NUCLEAR RNA SYNTHESIS IN CULTURE OF HeLa CELLS. Yatani, Ryuichi (Mie Prefectural Univ., Tsu, Japan). Mie Med. J., 15: 133-45(Sept. 1965).

The nucleolus of HeLa cells in growing cultures was selectively irradiated with a uv microbeam (about 2 μ in. dia), and subsequent incorporation of ^{3}H-cytidine into the RNA of the irradiated nucleolus and the extranucleolar part of the nucleus was chronologically examined for 24 hr by autoradiography, in combination with cinemicrography. After irradiation, inhibition of labeling not only appeared over the irradiated nucleolus, but also spread widely throughout the nucleus as a side-effect of nucleolar irradiation. The latter effect was found irrespective of the portion of the nucleus affected, the mode of action perhaps being nonspecific. The most effective enucleolation was obtained when about 20% of the control activity was retained in the irradiated nucleolus at four to five hr postirradiation, but at that time the control activity of the nuclear part was reduced to about 70%. However, these activities increased in the later postirradiation period. The recovery process was divided into two steps: a rapid recovering process that appeared a short time after irradiation and a slower recovery process in the latter half of the 24-hr observation period. (BBB)

28315 THE EFFECT OF FAR-ULTRAVIOLET LIGHT ON MITOCHONDRIA. Erecinska, Maria (Inst. of Biochemistry and Biophysics, Warsaw). Acta Biochim. Pol., 14: 21-30 (1967).

Rat liver and ox heart mitochondria is sucrose-EDTA medium were irradiated using a medium-pressure Hg lamp (257 mμ max) at 0°. Changes of volume (swelling) were followed as a decrease in extinction at 545 mμ in the same medium as used for irradiation for at least 20 min. Far-uv irradiation induced rapid and extensive swelling of rat liver mitochondria that depended upon the time of exposure and the amount of protein present in the irradiated mixture. The presence of ATP and Mn^{2+} or Mg^{2+} ions delayed the swelling. Formation of lipid peroxide during irradiation appeared to be the most likely explanation for the changes resulting in disintegration of the mitochondrial membrane. Ubiquinone disappeared from the irradiated mitochondria and the succinate dehydrogenase activity was inhibited markedly. Succinate dehydrogenase seemed to be the primary target by which the uv light was absorbed. The protective effect of albumin and nucleotides was nonspecific and related to their high absorption in the uv region. (BBB)

28316 EFFECT OF AMINO ACIDS ON ^{65}Zn INCORPORATION BY EHRLICH ASCITES TUMOR CELLS IN VITRO. Kuroda, Yoshio (Kyuden Hospital, Kashii, Fukuoka). Gann, 58: 481-3(Oct. 1967).

Tumor cells from ddN strain mice were incubated in ^{65}Zn-containing (as $^{65}ZnCl_2$) Krebs-Ringer solution to which various amino acids were added; its pH was adjusted to 7.4 by adding 1N NaOH. The final solution contained 0.98 μg of Zn, 0.5 μCi of radioactivity, and 0.01 millimole of the amino acid per ml. Radioactivity of the packed cells 120 min later was determined by a well-type scintillation counter system. The ^{65}Zn was incorporated gradually into tumor cells during the incubation. The uptake of ^{65}Zn was influenced by the kind of amino acid present in the reaction medium and the maximum uptake value was obtained by addition of L-histidine with unwashed cells (retaining ascitic fluid). With washed cells, a contrary effect, the diminished uptake of ^{65}Zn by L-histidine, was observed, using salt solution alone as the incubation medium. However, if the medium contained ascites fluid, the incorporation of ^{65}Zn was much higher with histidine than with other amino acids. When stereoisomers of the amino acids were added to the medium and their influence compared, no significant difference in ^{65}Zn incorporation was seen between the L- and D-isomers. This suggests that ^{65}Zn reached the tumor cell surface as a complex with amino acid

and was thereafter incorporated into the cell in another form. (BBB)

28317 REDISTRIBUTION OF ^{45}Ca IN TRIFOLIUM SUBTERRANEUM L. AND ANTIRRHINUM MAJUS L. Millikan, C. R.; Hanger, B. C. (Victorian Plant Research Inst., Burnley, Australia). Aust. J. Biol. Sci., 20: 1119-30(Dec. 1967).

Injection of nonradioactive Ca into leaf three of normal- or low-Ca clover (T. subterraneum) plants immediately after transfer to tracer-free solutions caused changes in the distribution of ^{45}Ca in the low-Ca plants only. In these plants the mean ^{45}Ca concentration in the laminae of all leaves was appreciably increased as a result of the influx of ^{45}Ca from the petioles. For both normal- and low-Ca plants, two weeks growth in tracer-free solutions reduced the mean ^{45}Ca concentration in both laminae and petioles of old leaves, while isotope appeared in new leaves produced during this period. Calcium injection at the end of this growth period caused a further reduction in mean ^{45}Ca concentration in laminae and petioles of old leaves, and movement of isotope into new leaves. This movement was mainly into the lamina center of the low-Ca and, to a much lesser degree, into the petioles of the normal-Ca leaves. Dialysis of ^{45}Ca in leaf two showed that these changes in concentration of the isotope were restricted to the water-soluble fraction in the normal-Ca samples. In the low-Ca samples small changes were also recorded in the fractions extracted by NaCl, $MgCl_2$, and HCl. With A. majus plants a much greater redistribution of previously deposited ^{45}Ca occurred in both original and new leaves of low-Ca plants transferred to tracer-free, normal-Ca solutions than in plants transferred to low-Ca solutions. Redistribution of ^{45}Ca occurred also in normal-Ca plants transferred to normal-Ca solutions and to a lesser extent in normal plants transferred to low-Ca solutions. This redistribution of ^{45}Ca continued between days eight and 16 after transfer to tracer-free solutions. Some ^{45}Ca artefacts were produced in autoradiographs by drying A. majus plants grown in normal but not in low-Ca nutrient solutions. (BBB)

28318 FEEDBACK INHIBITION OF THE DEVELOPMENT OF MACROPHAGE AND GRANULOCYTE COLONIES. I. INHIBITION BY MACROPHAGES. Ichikawa, Yasuo; Pluznik, Dov H.; Sachs, Leo (Weizmann Inst. of Science, Rehovoth, Israel). Proc. Nat. Acad. Sci. U. S., 58: 1480-6(Oct. 1967).

It was shown that macrophages in tissue cultures produce a substance that inhibits the activity of the inducer required for the development of macrophage (M) and granulocyte (G) colonies, and that M colonies are more effectively inhibited than G colonies. The inhibitor can diffuse through agar and is dialyzable. Inhibition of the activity of the inducer was obtained either by using a macrophage feeder layer in the assay for colony formation, or by incubation of the inducer with macrophages before the assay for inducing activity. The activity of the inducer was inhibited by macrophages from M colonies produced in vitro, from the spleen and peritoneal cavity of normal animals, and by macrophages x-irradiated with 4000 R, but not by macrophage feeder layers exposed to three cycles of freezing and thawing. The results indicate that the control mechanism that governs the growth and development of macrophages includes a feedback inhibition of the activity of the inducer by an inhibitor produced by what are presumably the mature differentiated macrophages. It is suggested that the inducer for G and M colonies be given the name mashran gm, and the macrophage inhibitor the name balam m. (auth)

28319 RAPIDITY OF ^{42}K EXCHANGE IN THE FUNCTIONING CANINE KIDNEY. Goldman, A. G.; Yalow, A. A.; Garelick, H.; Patrick, C.; Levitt, J. I.; Wolfman, M. (Montefiore Hospital and Medical Center, New York). Clin. Sci., 33: 285-99(Oct. 1967).

By direct injection of ^{42}K into the renal artery and analysis of the subsequent urinary specific activity curve, ^{42}K exchange in the functioning dog kidney was calculated to have a half-time of less than $2\frac{1}{2}$ min, but was probably significantly more rapid than indicated by this upper-limit calculation. This was consistent with the expectation that, because of its mode of delivery to renal tissue, the exchange of ^{42}K was a longer process than plasma transit across the kidney. The in vivo exchange rate was more rapid than that reportedly occurring in the large compartment of a separated tubular cell system, probably as a result of the increased metabolic activity of a filtering kidney. Intravascular ^{42}K was restricted to plasma during the period of observation and appeared to be limited in its exchange characteristics by the plasma flow rate. Variation in the magnitude of the exchanging pool of renal K may, therefore, be useful in the evaluation of alterations in the distribution of plasma flow within the kidney, and lead to a greater understanding of the interrelations between plasma flow and urine formation. (BBB)

28320 PROPERTIES OF POTATO STARCH IRRADIATED IN GAS MEDIA. Putilova, I. N.; Traubenberg, S. E.; Korotchenko, K. A. (Moscow Technological Inst. of the Food Industry). Izv. Vyssh. Ucheb. Zaved., Pishch. Tekhnol., No. 1, 48-52(1966). (In Russian).

Potato starch was irradiated in argon, carbon dioxide, air oxygen, and in vacuo using a ^{60}Co-γ source. Starch underwent less decomposition and oxidation during irradiation in argon or carbon dioxide than during irradiation in the other media. The maximum yield of radiolysis products was obtained from starch irradiated in an atmosphere of oxygen. During irradiation in vacuo (0.4 mm Hg), the starch retained only 2% moisture. Decomposition and oxidation of the starch was higher than during the process in other media; the low moisture content of the starch probably allowed the free radicals to recombine only with difficulty. (TSS) (JPRS)

28321 INACTIVATION OF INFECTIVITY OF RNA OF TOBACCO MOSAIC VIRUS DURING UV IRRADIATION OF THE WHOLE VIRUS AT TWO WAVELENGTHS. Kleczkowski, A.; McLaren, A. D. (Rothamsted Experimental Station, Harpenden, Eng.). J. Gen. Virol., 1: 441-8(Oct. 1967).

Loss of infectivity by tobacco mosaic virus exposed to uv radiation appeared to result entirely from changes in the RNA of the virus. Any changes that may have occurred in the virus protein did not seem to contribute to loss of infectivity of the virus, but there was an interaction between the protein and the RNA because free RNA was equally sensitive to inactivation by absorbed radiation energy of any wavelength (i.e., the extent of inactivation depended entirely on the number of absorbed quanta irrespective of the wavelength), while inside the virus the RNA was about 24 times more sensitive to inactivation at 230 mμ than at 280 mμ. Inside the virus the RNA seemed to be largely protected by the protein from damage by radiation of 280 mμ and 254 mμ, but not of 230 mμ to which it was about as sensitive as when free. Ultraviolet irradiation at any wavelength caused at least two kinds of damage to free RNA, one of which was photoreversible, but the photoreversible damage did not occur in the RNA irradiated when inside the virus. (BBB)

28322 MOLTING OF EUPHAUSIA PACIFICA AS A POSSIBLE MECHANISM FOR VERTICAL TRANSPORT OF ^{65}Zn IN THE SEA. Fowler, Scott W.; Small, Lawrence F. (Oregon State Univ., Corvallis). Int. J. Oceanol. Limnol., 1: 237-45(Oct. 1967).

The marine crustacean Euphausia pacifica, distributed throughout the northern Pacific, and often representing the largest biomass of the macroplankton, concentrates radiozinc. Thus, concentrations of ^{65}Zn of 10 to 25 μCi/l were found in the exoskeletons of E. pacifica. Since E. pacifica was an extremely abundant vertical migrant in the North Pacific, with a molting frequency of about five days, heavy accumulation of ^{65}Zn in exoskeletons could be a major mechanism of vertical transport of the isotope. Molted exoskeletons averaged 41% of total body activity prior to molting in uptake experiments, and in loss experiments 18%. Percentage loss from animals alternately accumulating and losing activity was about 30%. The ^{65}Zn activity in cast exoskeletons was correlated roughly with whole-body activity before molting, but apparently was not correlated with water temperature, animal size, or initial ^{65}Zn concentration in the water. The lack of correlation with these factors probably was due in part to size differences of exoskeletons and to removal of the exuvia from experimental flasks only at 24 hr intervals. Rates of ^{65}Zn loss from animals via molting were computed for three hydrographic conditions common to North Pacific waters. Assuming the same concentration of ^{65}Zn under the three conditions, highest loss rate was in a well mixed water column (^{65}Zn homogeneously distributed), lowest rate in the condition in which ^{65}Zn was distributed above a pycnocline in summer. Sinking of radioactive exuvia and ingestion of exuvia by other organisms were discussed. (BBB)

28323 STUDIES ON THE UPTAKE OF CADMIUM BY THE OYSTER, OSTREA SINUATE (LAMARCK). Brooks, R. R. (Massey Univ., Palmerston North, N. Z.); Rumsby, M. G. Aust. J. Mar. Freshwater Res., 18: 53-61(June 1967).

Radiometric experiments were conducted using oysters placed in seawater to which had been added $^{115}/^{115m}Cd$. The radioisotope was used two weeks after arrival to allow the short-lived ^{115}Cd (2.3 days) to decay. After this period, the isotope comprised mainly the longer-lived ^{115m}Cd (43 days). To study elution and displacement of adsorbed ions into filtered sea water and their displacement by adsorbed Cd, analyses for Cd, Ag, Mn, Pb, V, and Zn were carried out on freshly killed oysters, maintained for 100 hr in water or sea water containing 50 ppM Cd. Although a high Cd concentration did not appear to displace other ions, there was some evidence for loss of ions from the visceral mass.

Concentrations in oysters equilibrated with seawater containing added Cd, indicated that this element was strongly accumulated in the gills, visceral mass, and heart. These findings were confirmed by the uptake of $^{115/115m}$Cd from seawater containing this radionuclide. These experiments were also used to measure the rate of uptake of Cd which, although relatively slow, was appreciable in magnitude. Fractionation factors for the various organs for varying Cd concentrations in seawater showed a similar pattern for all organs studied and indicated cessation of uptake at Cd concentrations between 40 and 140 ppM. It was concluded that uptake was due to unselective adsorption probably by coordination to organic ligands. This theory was strengthened by radiometric experiments on the oyster heart where protein-bound Cd probably did not exceed 25% of the total. (BBB)

28324 ACCUMULATION OF ELECTRODIALYTICALLY SEPARATED PHYSICOCHEMICAL FORMS OF ^{106}Ru BY MUSSELS. Keckes, Stjepan; Pucar, Zvonimir; Marazovic, Ljerka (Rudjer Boskovic Inst., Zagreb). Int. J. Oceanol. Limnol., 1: 246-53 (Oct. 1967).

Radioruthenium either from reactor fuel processing plants or from weapon test fallout was among the most important artificial sources of marine environment radiocontamination. Nitrosyl and chloride complex forms of Ru, in which it occurred most frequently as radioactive waste, were composed of several physicochemical forms, fairly stable in sea water and defined by their electrophoretic and chromatographic mobility. Differences were found between the uptake rate of nitrosyl-nitrate and chloride complex forms of Ru in mussels, and further analyses of the differences in the uptake rate of electrodialytically separated physico-chemical forms of Ru nitrosyl nitrate and chloride complexes were made. The common mussel Mytilus galloprovincialis was used in the experiments. The ^{106}Ru nitrosyl-nitrate and chloro complexes were separated in seawater by electrodialysis through ion-exchange membranes, and biological uptake and loss experiments in the mussels were made with separated fractions. The metabolism of ^{106}Ru was found to be highly dependent not only on its chemical form but also on its physico-chemical form. The uptake of ^{106}Ru chloride fractions was faster than that of ^{106}Ru nitrosyl-nitrate fractions. Furthermore the uptake was higher in the soft tissues than in the shells of mussels. It seemed that the binding of ^{106}Ru in the shells was not as firm as in the soft tissues. (BBB)

28325 EFFECT OF THERAPEUTIC RADIATION UPON URINARY EXCRETION OF NUCLEASES AND DEOXYRIBOSIDES IN HUMAN PATIENTS WITH CARCINOMA OF THE CERVIX UTERI. Goldberg, D. M.; MacVicar, J.; Watts, C. (Western Infirmary, Glasgow). Clin. Sci., 32: 69-82(Feb. 1967).

Excretion of four enzymes that depolymerize nucleic acids and of deoxyribose derivatives was measured in the urine of ten patients with carcinoma of the cervix uteri before and during treatment with Ra and supervoltage therapy. Doses consisted of 5000 to 8500 RAD divided between conventional Ra insertion for periods ranging from 48 to 100 hr and given as one or two treatments, and supervoltage therapy was administered by a linear accelerator at 4 MeV. Results were expressed as a concentration, as 24 hr urinary output, and as excretion of the enzymes and deoxyribosides relative to that of creatinine. Urinary concentration of alkaline ribonuclease rose during Ra insertion, but the 24 hr output and the enzyme–creatinine ratio were unaltered. The concentration rose once more during the last two weeks of supervoltage therapy, when these changes were accompanied by a significant increase in the enzyme–creatinine ratio. Urinary excretion of acid ribonuclease ran parallel to that of the previous enzyme. There was a significant rise in the concentration during Ra insertion, and during the last two weeks of supervoltage therapy increases in the concentration and in the enzyme–creatinine ratio took place. Data are presented that suggest that alkaline and acid ribonuclease activities are properties of different enzymes. The 24 hr urinary output of deoxyribonuclease I fell significantly during Ra insertion, as did the enzyme–creatinine ratio. These changes were probably a consequence of enzyme inactivation by ionizing radiation. Urinary excretion of deoxyribonuclease II and of total deoxyribosides during radiotherapy did not change. (BBB)

28326 LASER RADIATION IN MEDICAL RESEARCH. Nunn, W. M. Jr. (Tulane Univ., New Orleans). Bull. Tulane Univ. Med. Fac., 26: 315-20(Nov. 1967).

The physical properties of laser irradiation, as compared to those of ionizing radiation, and the biologic response to laser radiation are reviewed. The process of stimulated emission of electromagnetic radiation, which underlies the operation of lasers, is explained. The highly directive, monochromatic, and coherent characteristics of laser radiation are in contrast to those of x irradiation which are randomly generated and broadly distributed in the spectrum. Although the thermal effects of focused laser beams have been widely described, attention is directed here to the use of lasers as coherent optical radiation sources in fundamental medical and biologic investigations. Aside from the heat-producing abilities of focused laser beams, intense electric radiation fields can induce photochemical changes, including weakening and breaking of chemical bonds, catalization, enhancement of polymerization, and formation of free radicals. High-power laser pulses can generate thermal stresses, hypersonic pressure waves, and recoil pressures capable of rupturing cellular membranes. Chemical changes can also occur as a result of transfer of molecular collisional energy to vibrational energy. However, the precise manner in which these and other complex physical phenomena combine to destroy cells is largely unknown. (BBB)

28327 ^{137}Cs METABOLISM IN BLATTA ORIENTALIS AT VARIOUS TEMPERATURES. Chuang, Tsin Fu (Purdue Univ., West Lafayette, Ind.); Snipes, Morris B.; Crawford, Clifford S.; Riedesel, Marvin L. Contract AT(29-2)-1629. Comp. Biochem. Physiol., 24: 997-1002(Mar. 1968).

The effect of environmental temperature on metabolic rate and on retention of orally administered ^{137}Cs in the oriental cockroach was studied, since poikilotherms represent an important portion of the total biomass and some contribute significantly to the movement of ^{137}Cs along food chains. In B. orientalis, following a single ingestion of the isotope, the extension of biological half-life resulting from lowering of temperature was greater than could be predicted from the reduction in metabolic rate that accompanied lowering of temperature. The retention of ^{137}Cs in a 10°C environment was in particular greater than would be expected for its retention in the 20 to 30°C temperature range. The data suggested that the metabolic rate alone was not the primary factor affecting retention of ^{137}Cs at 10°C. One possible explanation for these results concerns the probability of a considerable decrease in functional contact between Malpighian tubules and circulating fluids in the hemocoel at 10°C. A very slow rate of hemolymph movement could result in a greatly reduced amount of potential excretory product, Cs ions included, being brought in contact with the Malpighian tubules. Another possible explanation is that the presumably increased time spent by Cs in the ion-absorbing areas of the rectum at 10°C may have increased the probability of the isotope's transport back into the hemolymph. (BBB)

28328 ^{32}P METABOLISM IN TISSUES AND ORGANS AFTER SINGLE AND REPEATED INHALATION. Pugachevskii, V. P. (Scientific Research Inst. of Labor Hygiene and Occupational Diseases, Kiev). Med. Radiol., No. 12, 60-62(Dec. 1966). (In Russian).

Experiments on white mice forced to inhale ^{32}P showed that within an hour after a single administration of the isotope 75 to 90% was resorbed in the blood and delivered to various tissues and organs. ^{32}P disappeared from the tissues and organs exponentially. Approximately half of the isotope disappeared with an effective half-life of 0.3 to 1 day. The other half had an effective half-life one order higher. The storage of ^{32}P after chronic inhalation showed the same pattern as in the case of one-time inhalation. Calculations showed that the radiobiological parameters found for the various organs and tissues after one-time inhalation can be used to evaluate the chronic uptake of the isotope. (JPRS)

28329 CELLULAR COMPONENTS IN THE INDUCTION OF ANTIBODY BY X-IRRADIATED ANIMALS. Gallily, R.; Feldman, M. (Weizmann Inst. of Science, Rehovoth, Israel). pp 332-6 of Germinal Centers in Immune Responses. Proceedings of a Symposium Held at the University of Bern, Switzerland, June 22 to 24, 1966. Heidelberg, Springer-Verlag, 1966.

Studies on the cellular requirements for antibody formation indicated that germinal center formation is not an essential component of antibody production in x-irradiated mice, whereas functional macrophages may present a cellular limiting factor in the induction of a primary immune response in animals exposed to sublethal doses of total-body irradiation. The experiments were performed in mice exposed to 550 R total-body x irradiation. When they were challenged two days after exposure to Shigella antigen, tests for agglutinin formation after five and eight days were negative, but when the x-irradiated animals were injected with macrophages of peritoneal exudate that were incubated in vitro with Shigella, at doses of 15×10^6 cells per recipient, considerable amounts of antibody to the Shigella antigen were produced. An inverse relation was found between the irradiation dose given to the recipient animals and the capacity to form antibody following injection of primed macrophages, indicating that the lymphoid cells of the recipient reacted to the primed macrophages by producing antibody. Thus, the inoculation into lethally irradiated mice of primed macrophages and lymphoid

cells from either the thoracic duct or lymph nodes of normal donors resulted in antibody production, whereas the inoculation of any one of these components alone did not. Donor irradiation impaired the capacity of macrophages to elicit an immune response in x-irradiated mice; the higher the dose of irradiation of the donor, the lower the capacity of its macrophages to trigger an immune response. In none of these experimental systems was the production of antibody by the irradiated animal associated with germinal center formation. (BBB)

28330 THE USE OF ^{99m}Tc-LABELED SULFUR COLLOID TO STUDY PARTICLE DYNAMICS IN THE URINARY TRACT: VESICOURETERAL REFLUX. Corriere, Joseph N. Jr.; Kuhl, David E.; Murphy, John J. (Univ. of Pennsylvania, Philadelphia). Invest. Urol., 4: 570-5(May 1967).

Preparation of ^{99m}Tc-labeled colloidal S was described as well as a new method employing it to study ureteral reflux in rats and dogs. The suspensions of ^{99m}Tc-labeled S particles the size of bacteria were placed in the bladders of animals with and without ureterovesical reflux to determine the importance of this mechanism in the pathogenesis of renal infection. The ^{99m}Tc-labeled particles were prepared from an eluate of a Mo generator containing from 10 to 20 mCi of ^{99m}Tc diluted to 5 ml with 0.9% saline, to which 1 ml of 3N sulfuric acid and 4 mg of sodium thiosulfate were added and the mixture shaken vigorously for 1 min. The colloidal S was produced by the reaction: $Na_2S_2O_3 + H_2SO_4 \rightarrow NaSO_4 + H_2O + S$. Technetium-99m was coprecipitated with sulfur (probably as Tc_2S_7). Particles greater than 5 μ were removed by Millipore filtration. The final mixture contained 27 to 34% 1.2- to 5-μ particles, 24 to 27% 0.45- to 1.2-μ particles, and 42 to 46% particles less than 0.45 μ. Female Sprague–Dawley rats were inoculated transurethrally with 0.2 ml (100 to 300 μCi) of the colloid suspension, and hourly anterior scans were performed for 5 hr. The excised kidneys were scanned and counted in a well counter. In female dogs 10 ml (300 to 500 μCi) of the colloid suspension was placed in the urinary bladder through a catheter. Lateral scans of the bladders demonstrated that Brownian movement kept the colloid particles in homogeneous suspension throughout the studies. In the 12 rats studied, 19 to 24 kidneys had particles localized in the renal pelves by the 1st hr. No reflux was found in any of the scans of 4 normal dogs. In one dog, the urine pH was 7.0, and there was gastric concentration of radioactivity, presumably because of unbound ^{99m}Tc being absorbed through the bladder wall. If reflux was present in the dogs after surgical alteration of the ureterovesical junction, particles became evident in the kidneys immediately after inoculation. (BBB)

28331 ABILITY OF HEMATOPOIETIC SPLEEN COLONIES TO FORM MACROPHAGES IN VITRO. Virolainen, M.; Defendi, V. (Wistar Inst. of Anatomy and Biology, Philadelphia). Nature (London), 217: 1069-70(Mar. 16, 1968).

It has been shown that in mouse radiation chimaeras bone marrow is a source of alveolar macrophages and of macrophages which can be cultured from different organs. In the studies reported the relationship of macrophage origin to the granulocytic and erythrocytic series of differentiation was investigated by establishing macrophage cultures from hematopoietic spleen colonies of different cellular composition. The yield of macrophages was found to be correlated to the type of colony, and dividing macrophages had the same genotype as the donor cells used for the production of the colonies. In the experimental work described mice were given 820 R using a dual source ^{137}Cs irradiator at a dose rate of 180 R/min. Within 6 hours of irradiation the mice were injected with nucleated bone marrow cells. Spleen studies were then made. (UK)

28332 ULTRAMICROAUTORADIOGRAPHY ON THE INTRACYTOPLASMIC MULTIPLICATION OF THE PSITTACOSIS AGENT (6BC) IN CELL CULTURES. Higashi, Noboru; Matsumoto, Akira (Kyoto Univ.). Annu. Rep. Inst. Virus Res., Kyoto Univ., 8: 118-20(Dec. 1965).

An ultramicroautoradiographic technique was used to observe the incorporation of ^{3}H-thymidine and ^{3}H-cytidine by L-cell cultures that were infected with psittacosis agent (6BC). When the cells were incubated in a medium containing ^{3}H-cytidine, initial labeling was observed six hours after infection. Thereafter, labeling was located on the nucleolus and large particles. Four hours after infection, labeling was not observed on the particles that still showed the form of elementary particles but on the nucleus. In the medium containing ^{3}H-thymidine only the nucleus was labeled. It was shown by optical microscopic autoradiography that labeling by ^{3}H-cytidine was digested away when RNAase treatment was used. It was concluded that the incorporation of ^{3}H-cytidine was probably due to the uptake into RNA of the viral agent and of the nucleolus of the host cell; cytidine incorporation was initiated when the elementary particle in the cytoplasm changed into the large particle. (NSA of Japan) (TSS)

28333 RADIORESISTANCE OF PHYTOHEMAGGLUTININ-TREATED LYMPHOCYTES FROM NORMAL SUBJECTS AND FROM PATIENTS WITH HODGKIN'S DISEASE. Vergnano, F.; Cavallero, P.; Sartoris, S.; Pegoraro, L.; Fazio, M. (Univ., Turin). Panminerva Med., 8: 175-8(May 1966).

The effect of phytohemagglutinin (PHA), purified protein derivative (PPD, tuberculin), and 300 R x irradiation on cultures of lymphocytes from normal subjects and patients with Hodgkin's disease was investigated. With cells from normal subjects the survival rate of untreated lymphocytes in cultures ranged from 33 to 70%, with mean value of 51.4%. The survival rate of lymphocytes incubated with PHA ranged from 30 to 88% of the initial values, with a mean of 55.3%. Survival rate of cells incubated with PPD ranged from 25 to 80%, mean 45.7%. In the control cultures, the survival rate after irradiation ranged from 4 to 18%, mean 11%. In cultures incubated with PHA and irradiated, the survival rate ranged from 25 to 60%, mean 38.8%; in those incubated with PPD and irradiated from 10 to 42%, mean 23.2%. For lymphocytes from patients with Hodgkin's disease, the survival rate after six days of incubation ranged from 35 to 70% in the controls, mean 50.8%. When the cultures were irradiated with 300 R, the survival rate ranged from 0 to 33%, with mean 11.5%. The survival rate of lymphocytes incubated with PHA ranged from 33 to 80%, with a mean 59.2%; after PPD treatment it ranged from 5 to 80%, mean 46.5%. Cultures irradiated with 300 R showed a survival rate of 15 to 74%, mean 40.7%, when incubated with PHA, and from 8.2 to 40%, mean 25.7%, when incubated with PPD. No significant difference was found between the survival rate of lymphocytes from patients with Hodgkin's disease with positive or negative tuberculin skin tests when exposed to PHA or PPD. It was concluded that PHA increased the survival of irradiated lymphocytes four fold and PPD two fold. (BBB)

28334 DIETARY INORGANIC PHOSPHORUS EFFECTS ON RETENTION AND DEPOSITION OF ^{89}Sr. Colvin, L. B.; Creger, C. R.; Ansari, M. N. A.; Allen, W. S.; Couch, J. R. (Texas A and M Univ., College Station). Poultry Sci., 46: 895-9(July 1967).

Chicks were fed starting diets containing 1% total Ca supplemented with 0.1, 0.5, 1.0, and 2.0% inorganic phosphate (IP) supplied as H_3PO_4. All birds were injected subcutaneously with 4.88 μCi ^{89}Sr ($SrCl_2$). At 2, 7, and 12 days following injection of the isotope, the ^{89}Sr content was estimated in the right and left tibiotarsus, eyes, and brain. The latter two tissues were analyzed for ^{89}Sr content because previous work had indicated that the isotope may be found in these tissues. All excreta were collected daily for estimation of ^{89}Sr content. The greatest concentration of ^{89}Sr in tissue analyzed was found in the bone. Specific activity of the bone ash was lowest in birds receiving 0.1 and 0.5% IP at each sampling period, the concentration of ^{89}Sr in the bones of these two groups being essentially the same. The ^{89}Sr content of bone tissue was slightly greater at two days following injection of ^{89}Sr in birds receiving 1.0% dietary IP; however, at seven and 12 days (postinjection time) birds receiving the highest level of dietary IP (2.0%) retained the largest amount of ^{89}Sr in the bones. In the eyes the amount of ^{89}Sr retained at 12 weeks of age was nearly the same in all groups, on the basis of specific activity of ash, due to dilution of the isotope by growth. However, if percentage of the total dose was considered, the amount of ^{89}Sr retained actually increased as the IP content of the diet was increased. The activity recovered in the excreta was highest in the group receiving the lowest P level. The birds receiving 0.1% P excreted 81% of the injected dose in 12 days; whereas the group receiving 2.0% P excreted only 54% of the injected dose. (BBB)

28335 PHYSICOCHEMICAL INVESTIGATION OF THE MECHANISM OF INACTIVATION OF ENZYMES. III. THERMODYNAMIC ANALYSIS OF THE STRUCTURAL-CHEMICAL CHANGES IN PROTEINS ON RADIATION INACTIVATION. Eidus, L. Kh. (Inst. of Biological Physics, Moscow). Biophysics (USSR) (Engl. Transl.), 11: 684-7(1966).

Translated from Biofizika, 11: 601-4(1966).

A technique is proposed for studying the structural chemical changes in individual stages of radiation inactivation of enzymes consisting in the application of the method of Eyring and Stearn of thermodynamic analysis of protein denaturing to the reaction of thermal radiation after-effects. During formation of latent damage in the molecules of myosin and pepsin 10 to 15 hydrogen bonds were disturbed while the covalent bonds did not rupture; in the second stage of inactivation, there was rupture of one covalent (apparently disulfide) and 3 to 4 hydrogen bonds. The hypothesis is put forward that disturbance in the hydrogen bonds in the first stage of inactivation occurred through the polarization effect of Platzman and Franck; however, only after preliminary migration and localization of the charge in the weak points of the structure, in particular the S–S bridges. The fusion of a part of the protein molecule in this region in the first stage of

inactivation ensured the possibility of realization of the second stage. (auth)

28336 ^{239}Pu IN LIVER, SPLEEN, AND KIDNEYS OF THE BEAGLE. Stover, Betsy J.; Atherton, David R.; Bruenger, Friedrich W.; Buster, Dawn S. (Univ. of Utah, Salt Lake City). Health Phys., 14: 193-7(Mar. 1968).

The initial deposition of ^{239}Pu in the liver is independent of injected dose over the range 0.096 to 2.8 μCi/kg. Long term hepatic retention is, however, a function of both the injected dose and time since injection. The rate of decrease is proportional to the early radiation dose rate to the liver. A similar effect was not observed in renal and splenic retention of ^{239}Pu. The radiation dose rates to these tissues are considerably less than that to the liver. (auth)

28337 RADIATION-INDUCED EFFECTS ON DNA SYNTHESIS IN DEVELOPING SEA URCHIN EGGS. Zeitz, L.; Ferguson, R.; Garfinkel, E. (Sloan-Kettering Inst. for Cancer Research, New York). Radiat. Res., 34: 200-8(1968).

Naturally synchronous populations of developing sea urchin eggs were used in studies of the mechanism of radiation damage. Experiments showed the effect on DNA synthesis in the developing eggs of Strongylocentrotus purpuratus fertilized with sperm which were irradiated with sublethal doses of x rays of ultraviolet radiation. The profiles of the first DNA synthetic period (S period), as measured by the uptake of tritiated thymidine (^{3}H-TdR) into the acid-insoluble fraction, were identical for developing eggs fertilized with irradiated and nonirradiated sperm. There was a radio-induced delay in the second S period equal to the division delay. However, the rate and amount of DNA synthesis in this second S period were unaffected by the radiation. The same type of radio-induced effect was found with gametes of the sea urchin Arbacia punctulata where the sperm are x irradiated. (auth)

28338 SELECTIVE THIAMINE REMOVAL FROM CULTURE MEDIA BY ULTRAVIOLET IRRADIATION. Button, D. K. (Univ. of Alaska, College). Appl. Microbiol., 16: 530-1(Mar. 1968).

Thiamine-free culture media was prepared for use in the study of cell growth kinetics by exposure to an external source of uv radiation. (C.H.)

28339 RESTORATION OF STEM CELL FUNCTION AFTER IRRADIATION. PART IV. KINETICS OF ERYTHROPOIESIS AND SITES OF ACTION OF ERYTHROPOIETIN. Porteous, D. D.; Lajtha, L. G. (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Ann. N. Y. Acad. Sci., 149: 151-5(Mar. 29, 1968).

Studies on the restoration of stem cell function following the injection of suspensions of bone marrow cells into heavily x-irradiated polycythemic mice are reported. Results indicate that restoration of stem cell function in spleen colonies formed by the injected cells are different from those observed in intact animals. (C.H.)

28340 SUMMARY OF SOME STUDIES ON ERYTHROPOIESIS USING ANTI-ERYTHROPOIETIN IMMUNE SERUM. PART V. IMMUNOLOGICAL STUDIES ON ERYTHROPOIETIN. Schooley, John C.; Garcia, Joseph F.; Cantor, Linda N.; Havens, Virginia W. (Univ. of California, Berkeley). Ann. N. Y. Acad. Sci., 149: 266-80(Mar. 29, 1968).

Current information on the preparation and properties of anti-erythropoietin immune serum and the usefulness of anti-erythropoietin in various studies on the regulation of erythropoiesis are discussed. Results are reported from studies on the behavior of colony-forming cells in hypoxic mice injected with anti-erythropoietin, in polycythemic mice irradiated with 200 R and in heavily irradiated mice given a bone marrow transplant that support the concept that erythropoietin does not act directly upon the colony-forming cell but upon a population of erythropoietin-sensitive cells derived from the colony-forming cell population. Some speculations regarding the characteristics and behavior of the erythropoietin-sensitive cell are presented. (C.H.)

28341 INFLUENCE OF DIETARY POTASSIUM, RUBIDIUM, OR SODIUM ON THE RETENTION TIME OF RADIOCESIUM IN RATS. Johnson, James E.; Garner, Daphne; Ward, Gerald M. (Colorado State Univ., Fort Collins). Proc. Soc. Exp. Biol. Med., 127: 857-60(Mar. 1968). (COO-1171-67).

Increasing the K intake of rats above requirements reduced the half-retention time for ^{134}Cs but at a decreasing rate. Maximum intake was 5% which resulted in $T_{\frac{1}{2}}$ of 6 days. The Na added at 0.3 or 2% to high K diet had no influence on the $T_{\frac{1}{2}}$ for ^{134}Cs. The influence of Rb salts on ^{134}Cs retention would indicate that this ion is less effective than K. The decreased effect of Rb may be due to its failure to adequately substitute for K in normal muscle cell metabolism. (auth)

28342 EFFECTS OF KINETIN ON CHLOROPHYLL BREAKDOWN AND PROTEIN LEVELS IN IRRADIATED BARLEY LEAVES. Giacomelli, M.; Donini, Maria Laura Belli; Cervigni, T. (CNEN, Rome). Radiat. Bot., 7: 375-84(Oct. 1967).

It has been shown that kinetin delays the typical phenomena of senescence, such as chlorophyll and protein degradation, in detached leaves. The ability of kinetin to delay these processes also in irradiated leaves was investigated. Eight day old first emerged leaves of barley (cv. ESAU) were detached and irradiated with x rays at 0, 10, 30, and 50 kR. After irradiation the leaves were placed with their basal ends in beakers containing (a) distilled water and (b) aqueous solutions of kinetin (2 μg/ml). After 3, 5, 7, and 10 days from irradiation, analyses of chlorophyll and soluble protein content were made. The results show that the kinetin is able to delay chlorophyll degradation in irradiated leaves. Kinetin, however, does not entirely repair the damage caused by radiation; in fact the chlorophyll content is always lower in irradiated leaves regardless of kinetin treatment. In unirradiated leaves untreated with kinetin a decrease in protein content during the first three days of treatment can be observed, but in the following days the protein content remains almost constant. In unirradiated leaves treated with kinetin the protein content decreases during the first 3 days and then increases up to values almost equal to initial. In irradiated leaves not treated with kinetin the protein content follows a similar behavior to that of the unirradiated control leaves. In irradiated leaves treated with kinetin the decrease of protein content is lower than in the unirradiated leaves, particularly for the highest exposures. The mechanisms by which kinetin acts on chlorophyll and protein preservation in irradiated material are discussed. (auth)

28343 OBSERVATION OF VERY WEAK LUMINESCENCE OF ORGANISMS IN AN ATMOSPHERE OF DIFFERENT GASES ON EXPOSURE TO IONIZING RADIATION AND HEAT. Avakyan, Ts. M.; Adzhyan, N. S. (Research Inst. of Agriculture, Echmiadzin, USSR). Biophysics (USSR) (Engl. Transl.), 11: 829-35(1966).

Translated from Biofizika, 11: 717-22(1966).

A new apparatus that makes it possible to record chemiluminescence of biosubstrates with simultaneous action of different gases, temperature and x rays is described. Results are presented for the following experiments: temperature dependence of intensity of chemiluminescence of oleic acid; chemiluminescence of oleic acid on exposure to x rays; change in the chemiluminescence of oleic acid on simultaneous exposure to x rays and nitrogen; and dependence of intensity of chemiluminescence on time in an atmosphere of nitrogen and air. (H.L.W.)

28344 KINETICS OF THERMAL INACTIVATION OF ULTRAVIOLET IRRADIATED SOLUTIONS OF TRYPSIN. II. Luzikov, V. N.; Troshkina, T. V. (Moscow State Univ.). Biophysics (USSR) (Engl. Transl.)., 11: 805-10(1966).

Translated from Biofizika, 11: 701-4(1966).

Solutions of trypsin were kept at a temperature of –2°C during irradiation and later heated in an ultra thermostat. Heating a solution kept for a long time at 26 to 96°C that had been irradiated with uv led to rapid inactivation of the enzymes. The total depth of the process corresponded well with the findings obtained for direct thermal inactivation (96°C) of trypsin irradiated with the same dose. Heat inactivation of the irradiated solution of trypsin was of an irreversible character. Prolonged incubation at low temperature (+3°C) did not lead to reactivation. Thus, the value of the specific enzymatic activity in the heat inactivated solution did not increase if the activity was determined after 24 hr at +3°C as compared with the specific activity measured in the case of 40 min incubation at the same temperature after heating. (H.L.W.)

28345 IONIZING RADIATION EFFECTS ON STARCH AS SHOWN BY STAUDINGER INDEX AND DIFFERENTIAL THERMAL ANALYSIS. Saini, Veena (Ohio State Univ., Columbus). J. Food Sci., 33: 136-8(Mar.-Apr. 1968).

Corn starch in the form of raw granules at commercial moisture was irradiated at two levels: 3×10^6 and 6×10^6 rad from a ^{60}Co source. The irradiated samples were completely dissolved in alkali, indicating there was no cross linking induced in the starch molecules by irradiation. Viscosity determinations of starch solution diluted with distilled water exhibited the ion charge effect generally observed in other macromolecules. The Staudinger indices of unirradiated, irradiated at 3×10^6 rad and 6×10^6 rad were 42, 22, and 16, respectively, which were an indication of depolymerization of starch macromolecules with increasing irradiation. The differential thermal analysis of the three samples also showed the depolymerization of the polymer with irradiation. It is suggested that these two simple techniques, the Staudinger index and DTA, could be usefully employed to characterize small differences in starches. (auth)

28346 LABELING OF TOBACCO MOSAIC VIRUS WITH ^{125}I. Mayo, M. A.; Cocking, E. C. (Univ. of Nottingham, Eng.). J. Gen. Virol., 2: 89-97(Jan. 1968).

A simple and rapid in vitro radioiodine labeling technique is described that was used for preparing tobacco mosaic virus labeled with ^{125}I. The technique was versatile and could be used to obtain labeled virus of both high and low specific activity. Radioiodination was carried out in siliconized glass vials by mixing a volume of concentrated virus suspension with a solution of iodine in neutral aqueous KI. For labeling, carrier-free $Na^{125}I$ was added to a dilute solution of iodine and a sample of virus added, the amount being calculated to be equivalent to the iodine in solution on the basis of each sulfydryl group on each protein subunit of the virus reacting with two atoms of I, one of which becomes bound. The mixture was incubated at room temperature for 30 to 40 min, and a slight excess of 0.005N sodium thiosulfate added to convert any unreacted iodine to iodide. In the case of high-activity preparations virus was separated from contaminating radioiodide by centrifugation at 35,000 rpm. When the level of activity was lower, gel filtration was used. High specific activity virus was used in a pilot radioautographic experiment at the electron microscope level, and micrographs were obtained showing virus particles in close association with silver grains. At specific activity of 2 to 3 mCi/mg a rapid loss of infectivity was observed after labeling; this effect was not observed when the specific activity was 1 μCi/mg. The sensitivity of detection for high specific activity preparations by scintillation counting and by electron microscope radioautography was discussed and the potentiality of ^{125}I-labeled virus of both high and low specific activity was indicated. (BBB)

28347 MODIFICATION IN ARYLAMINE LEVELS IN THE BLOOD OF RATS FOLLOWING INJURY BY IONIZING RADIATION. Kalina, C. (Charles Univ., Prague). Radiobiol.-Radiother., 8: 539-40(1967).

Evidence for the influence of ionizing radiation on macromolecules in vivo was substantiated by a study of the effects of x radiation on the levels of arylamine mobilized in the blood of rats. One hundred and seventy-eight rats were subjected to a 700 R dose of x ray and sacrificed in groups of 10 at 24 hr intervals following irradiation. Rises in the arylamine content of the blood first appeared in some rats three days post-irradiation and again seven days post-irradiation. The evidence suggests that the rise in arylamine content of the blood following irradiation is a manifestation of catabolic processes. That variations exist in radiosensitivity of individuals in a race of rats, was also substantiated. (E.R.B.)

28348 THE CHANGE OF TRANSAMINASE ACTIVITY FOLLOWING X-IRRADIATION AND HEPATECTOMY IN RATS. Soevenyi, E.; Thury, G.; Tenyi, M. (Medical Univ., Szeged). Radiobiol.-Radiother., 8: 523-8(1967). (In German).

At different periods (30 and 48 hr, respectively, five and 15 days, respectively) after partial hepatectomy (extirpation of 70% of liver-substance) rats were whole-body irradiated with 800 R. Five days after irradiation and five days after excision of the liver, respectively, glutamic-acid-oxalacetic acid-transaminase (GOT) activity levels were determined in serum and hepatic tissue according to the Dubach method and the behavior of GOT levels in the single serum-protein fractions was followed by means of agar-gel electrophoresis. Enzymic activity in hepatic tissue and blood-serum was significantly increased after partial hepatectomy as well as after x irradiation. In serum-protein fractions the increase in activity of GOT following the resection of the liver is demonstrable in α_2-globulin. Thirty to 48 hr after partial hepatectomy and irradiation the highest GOT-activity is found in the α_2-globulin fraction as opposed to the irradiated only animals where the increase in enzymic activity is observed in β-globulin fraction. A similar increase in activity in the α_2-globulin fraction was also present when the partial hepatectomy was performed at different times after irradiation. (auth)

28349 THE EFFECT OF IRRADIATION ON IRON UPTAKE OF LIVER-CELLS IN VITRO. Miltenyi, L.; Adam, G.; Jona, G. (Univ., Debrecen, Hungary). Radiobiol.-Radiother., 8: 529-31 (1967). (In German).

Following a whole-body irradiation with a total dose of 200 R and four at oxygen-pressure, the iron binding capability of liver cells in vitro was measured. In comparison with the results of former examinations these values are similar to data of a usual whole-body irradiation of 400 R. Thus radiation effect is doubled by oxygen. The increased iron uptake is interpreted by an increased requirement of iron. (auth)

28350 CONCENTRATION AND STATE OF CERIUM IN COASTAL WATERS. Carpenter, James H.; Grant, Virginia E. (Johns Hopkins Univ., Baltimore). J. Marine Res., 25: 228-38 (Sept. 15, 1967).

Interest in Ce distribution in seawater has increased as a result of the introduction of Ce radioisotopes into marine waters. Cerium contents of several coastal water samples were found to be 0.1 to 0.6 μg/l. These were in contrast to the Ce concentrations of 0.004 and 0.014 μg/l in samples taken near Bermuda. The edible portions of several marine organisms were analyzed to determine Ce concentration factors. These were observed to be less than 20 for striped bass (Roccus saxatilus), less than 100 for oysters (Crassostrea virginica), and 1000 for soft clams (Mya arenaria). Radiocerium (^{141}Ce) added to coastal waters became associated with the natural solids, particularly material with apparent diameter of 0.02 to 0.1 μ. Removal of the natural solids permitted apparent solubility of several micrograms per liter for added ^{141}Ce. Fluorometry was used to observe oxidation of Ce(III) to seawater. The oxidation was pH dependent, indicating the importance of ceric hydroxide precipitation and complexing. The oxidation was inhibited by increased phosphate concentrations, suggesting a strong phosphate complex. (BBB)

28351 AMERICIUM AND PLUTONIUM URINE EXCRETION FOLLOWING ACUTE INHALATION EXPOSURES TO HIGH-FIRED OXIDES. Hammond, S. E.; Lagerquist, C. R.; Mann, J. R. (Dow Chemical Co., Golden, Colo.). Amer. Ind. Hyg. Ass. J., 29: 169-72(Mar.-Apr. 1968).

Twenty-five persons incurred measurable inhalation exposures during a plutonium fire in 1965. Exposures ranged up to 17 times the maximum permissible lung burden as estimated by whole-body counting. Urine excretion of Am and Pu was studied for six months following the accident. The ratio of Pu to Am α activity in the urine averaged 1.5 to 1. The exposure material initially contained an α ratio of 11 to 1 Pu to Am. There was no apparent change in this ratio with time during the period of study. Typical excretion curves for subjects treated with DTPA and for nontreated subjects are discussed. (auth)

28352 STRONTIUM RETENTION AS A FUNCTION OF AGE IN THE DOG. Anderson, John J. B.; Comar, C. L. (New York State Veterinary Coll., Ithaca, N. Y. Cornell Univ., Ithaca, N. Y.). Radiat. Res., 34: 153-69(1968).

The study of bone turnover in purebred beagles as related to initial retention and loss of alkaline earths was undertaken to determine the effect of age on the retention of a single intramuscular injection of ^{85}Sr. From several litters one dog each was dosed with 5 μCi of ^{85}Sr at birth and at 2, 5, 8, and 10 months of age. Whole-body measurements of the dogs yielded the following average fractional retentions on day one postinjection: birth, 0.90; two months, 0.86; five months, 0.75; eight months, 0.62; and ten months, 0.69. On postinjection day 200 the retentions were, respectively, 0.29, 0.28, 0.35, 0.26, and 0.26. The greatest retention at 200 days was observed in the dogs dosed at five months of age, which is somewhat before the age of puberty. By five months of age, the rapid phase of growth was approaching completion, and, hence, bone turnover was decreasing to a level observed in mature dogs. The autoradiographic distribution patterns of ^{85}Sr as a function of age within litters of mongrel dogs injected at different ages revealed that the remodeling of growth released the radiolabel from areas of high concentration resulting from bone formation at the time of injection. (auth)

28353 EFFECTS OF DNA REPAIR IN TRANSFORMATION-HETEROZYGOTES OF PNEUMOCOCCUS. Guerrini, F.; Fox, M. S. (Massachusetts Inst. of Tech., Cambridge). Proc. Nat. Acad. Sci. U. S., 59: 1116-31(Apr. 1968).

Further evidence is presented supporting the heteroduplex heterozygote structure of the recombinant region of DNA in transformed Diplococcus pneumoniae. It was demonstrated that under normal circumstances conversion does not occur prior to replication. Following treatment with mitomycin C (MC) or uv, conversion does occur, indicating that repair following excision takes place on the template of the complementary strand. (auth)

28354 DATA ON THE INTERRELATIONS BETWEEN THE RADIATION AND THE CELL PHOSPHATES. Nagy, Eva J.; Elekes, Istvan. Magy. Radiol., 20: 1-6(Jan. 1968). (In Hungarian).

Starting from the supposition that the cell phosphates play a specific role in cell division, the control phosphate fraction of the yeast cell (Saccharomyces cerevisiae) under different cultivation conditions was studied with emphasis on the metabolic activity of the acid-insoluble polyphosphates is in the yeast cell. It was found that in ^{32}P irradiated cells the phosphate content of the acid-insoluble fraction was significantly higher, perhaps because the energy applied otherwise for cell division is used automatically for the accumulation of polyphosphates. (auth)

28355 SURVIVAL AND RECOVERY AFTER X IRRADIATION OF SYNCHRONIZED CHINESE HAMSTER CELLS IN CULTURE.

Sinclair, Warren K. (Argonne National Lab., Ill.). Idengaku Zasshi, 40: Suppl., 141-61(1965).

Results of studies made on an established subline of x-irradiated Chinese hamster lung cells are reported, including some features of the asynchronous cell population used and its radiation response. Also described are the technique used for obtaining a synchronized population, degree of synchrony achieved, x radiation response with age at various doses, and repair of radiation damage studied by the 2-dose method. The x-ray response of synchronized populations with age showed the greatest resistance in the S phase with G_1 and G_2 being about equally sensitive. Survival curves showed the resistance in S to be primarily due to an increase in the shoulder of the curve, indicating that cells in this condition can withstand greater amounts of sublethal damage. Secondarily, a change in shape of the curve, indicating a possible greater slope for cells in S, also occurred. Two-dose experiments indicated that Chinese hamster cells in the S period which survive a first dose of x rays repair fully the sublethal damage incurred as defined by their ability to form colonies when challenged by a second dose. This repair process is rapid and may be complete by two to three hr; it is certainly complete just after the next division. Irradiated cells continue to progress slowly through the cycle. The kinetic pattern of recovery for asynchronous cells exposed to 2-dose fractions is due to the combined effects of partial synchronization of survivors, rapid recovery from sublethal damage, and subsequent progression through the cycle. Cells irradiated at cell ages other than S (e.g., in G_1 and G_2 phases) probably also recover but such experiments are complicated by the presence of a few S cells. (BBB)

28356 FUNCTION OF MACROPHAGES IN THE INDUCTION OF ANTIBODY PRODUCTION IN X-IRRADIATED ANIMALS. Feldman, Michael; Gallily, Ruth (Weizmann Inst. of Science, Rehovoth, Israel). pp 39-48 of Ontogeny of Immunity. Part II. Gainesville, Florida, Univ. of Florida Press, 1967.

A comparison was made of the capacity of macrophages from normal and x-irradiated mice to elicit antibody production in irradiated mice, when injected after in vitro interaction with Shigella antigen. Such peritoneal macrophages from normal mice exposed to Shigella triggered the production of agglutinating antibody to the bacterial antigen when injected into mice treated with 550 R total-body x irradiation. Irradiated mice did not respond when injected with the antigen alone. The antibody formed was not produced by contaminating lymphocytes of peritoneal exudates since pure populations of macrophages, obtained after in vitro culturing of the cells, were similarly effective in inducing antibody. Nor could the production of antibody be attributed to the inoculated macrophages themselves having undergone lymphoid transformation, as shown by the inverse relation between the dose of irradiation to the recipient and the level of antibody obtained following macrophage inoculation. It was thus demonstrated that cells of the irradiated recipients produced antibody due to the triggering effect of macrophages from normal animals. Macrophages from irradiated donors, incubated with Shigella were incapable of inducing antibody production in x-irradiated mice. Therefore, the immunological suppression obtained following sublethal doses of total-body irradiation is at least partly due to the impaired capacity of macrophages to process the antigen. This may explain the susceptibility of such animals to the induction of immunological tolerance. (BBB)

28357 KINETICS OF STEM CELL DEPLETION AND PROLIFERATION: EFFECTS OF VINBLASTINE AND VINCRISTINE IN NORMAL AND IRRADIATED MICE. Smith, Willie W.; Wilson, Shirley M.; Fred, Sallie S. (National Cancer Inst., Bethesda, Md.). J. Nat. Cancer Inst., 40: 847-54(Apr. 1968).

Vinblastine (VLB) caused a depression followed by an overcorrection in colony-forming units (CFU) of mice, as assayed by transplantation of spleen and marrow cells into γ irradiated recipients. Two days after VLB injection the femur showed a greater loss in nucleated cells than in CFU, resulting in a threefold increase in CFU concentration. The fraction of CFU recovered from the recipient spleen was 0.08 in these mice, compared to 0.20 for controls. On the basis of this lower transplantation fraction, the concentration of colony-forming cells in the femur is estimated to be 2/100 nucleated cells. Mice irradiated 2 days after an injection of VLB or vincristine showed a marked increase in endogenous splenic colonies and an early proliferative recovery of CFU. With VLB and 400 rads, exponential growth of femoral CFU began immediately, with no dip or lag phase apparent. This could not be attributed to an increased number of CFU at the time of irradiation or to a decreased radiation sensitivity. The effect was not seen in untreated mice given 200 rads, where the survival fraction was seven times that for 400 rads. The CFU recovery pattern in mice pretreated with VLB appears therefore to result from a qualitative effect on the cells, which promotes early resumption of cell division after irradiation. (auth)

28358 ELECTRON SPIN RESONANCE OF A GAMMA-IRRADIATED SINGLE CRYSTAL OF 3'-CYTIDYLIC ACID. Bernhard, William; Snipes, Wallace (Pennsylvania State Univ., University Park). Contracts AT(30-1)-3799; NsG-324. Proc. Nat. Acad. Sci. U. S., 59: 1038-44(Apr. 1968).

The primary radical formed in 3'-cytidylic acid by γ irradiation at room temperature was studied by ESR spectroscopy. The unpaired electron is localized on a carbon atom and has hyperfine interaction with one α proton and one β proton. A detailed comparison of the g tensor and the α proton hyperfine tensor with the known crystal structure shows that the radical most probably has the unpaired electron on $C_{4'}$ of the ribose sugar moiety. (auth)

28359 ^{65}Zn AND STABLE ZINC ABSORPTION, EXCRETION, AND TISSUE CONCENTRATIONS AS AFFECTED BY TYPE OF DIET AND LEVEL OF ZINC IN NORMAL CALVES. Miller, W. J.; Martin, Y. G.; Gentry, R. P.; Blackmon, D. M. (Univ. of Georgia, Athens). J. Nutr., 94: 391-401(Mar. 1968).

The effects of dietary Zn level (2 vs 38 ppM) in a purified diet and of a practical vs a purified diet with the same Zn level (38 ppM) on ^{65}Zn metabolism were determined following a single oral dosing in 2.5- and 415-month-old male Holstein calves. They were killed 14 days after ^{65}Zn dosing and before those given the Zn-deficient diet developed a deficiency. Calves fed the low-Zn purified diet absorbed considerably more ^{65}Zn, but there was little overall difference between groups fed the practical-type diet and the purified diet with added Zn. Those given the practical diet had a higher fecal endogenous ^{65}Zn excretion the second week after dosing. Younger calves absorbed a much higher percentage of ^{65}Zn from diets with adequate Zn than older ones in the later experiment. There was no difference in net ^{65}Zn retention due to age among those given the Zn-deficient diet; this suggested that differences associated with age were not caused by reduced ability of animals to absorb Zn but rather to effects of other factors on the homeostatic control mechanism. Tissue samples from calves given the deficient diet retained much more of the administered ^{65}Zn dose in all tissues than those given Zn-adequate diets. (BBB)

28360 EFFECTS OF IONIZING RADIATION ON NUCLEIC ACIDS DURING EMBRYONIC DEVELOPMENT: METABOLISM DURING EMBRYOGENY AND AT EMBRYONIC TISSUE LEVEL. Chang, C. W. (Michigan State Univ., East Lansing). Can. J. Bot., 46: 51-6(Jan. 1968).

Observation was made of effects of X-irradiation on DNA and RNA metabolism by means of rates of ^{32}P incorporation into the nucleic acids during barley embryogeny. Levels of disturbances in ^{32}P incorporation rates into DNA caused by X-rays are correlated inversely with the periods of postirradiation and proportionally related to tissue heterogeneity at the time of X-irradiation with the exception of the oldest embryos. Changes in ^{32}P labelling of RNA induced by X-rays during barley embryonic development, however, are independent of the postirradiation periods and differences in the tissue heterogeneity. The levels of differences due to X-rays in ^{32}P incorporation rates into the DNA of the three different regions of a mature embryo reflect the degree of tissue heterogeneity within the embryos at the time of X-ray treatment. Disturbances in the rates of ^{32}P incorporation into DNA are greatest in the root tissue and least in the scutellar region; the shoot part is rated between the levels of the two tissue regions. In contrast, responses of ^{32}P labelling rates of RNA to X-rays in the three different parts of a mature embryo are found to be independent of the tissue heterogeneity at the time of X-ray treatment and the postirradiation period during embryogeny. (auth) (UK)

28361 AUTORADIOGRAPHIC STUDIES ON THE DISTRIBUTION OF ^{65}Zn IN MICE. Bergman, Bo; Soremark, Rune (Univ. of Umea, Sweden). J. Nutr., 94: 6-12(Jan. 1968).

The distribution of ^{65}Zn in various organs and tissues was examined simultaneously by use of a whole-body autoradiographic technique after ^{65}Zn as the chloride in isotonic solution was injected intraperitoneally in adult mice, including pregnant females. The kinetics of ^{65}Zn was generally found to be rapid. However, the uptake of ^{65}Zn in the hard tissues and the central nervous system was slower than in other tissues. The ^{65}Zn was transported through the placenta into the fetus, and at two hr a high uptake was visible in the fetal bones and in the liver. Accumulation of ^{65}Zn was found in liver, kidney, urinary bladder, lung tissues, pancreas, gastric and intestinal mucosa, hard tissues, and cartilage. A relatively high concentration was also found in the retina and choroid of the eye, testes, lactating mammary glands, salivary and lacrimal glands, spleen, hair follicles, and hair. The ^{65}Zn level in blood, skeletal muscles, central nervous system and pituitary gland was low. After two hr and longer periods the concentration of ^{65}Zn in the hard tissues dominated the distribution pattern. (BBB)

28362 DEOXYRIBONUCLEIC ACID REPLICATION IN λ BACTERIOPHAGE MUTANTS. Salzman, Lois Ann; Weissbach,

Arthur (National Inst. of Arthritis and Metabolic Diseases, Bethesda, Md.). J. Virol., 2: 118-23(Feb. 1968).

After uv light induction of Escherichia coli K12 strain W3350 (λ), several structural intermediate forms of phage DNA were synthesized. Synthesis of λ DNA after lysogenic induction was measured by the amount of incorporation of radioactive thymidine. This method had the disadvantage of not distinguishing between λ DNA synthesis and the synthesis of the host bacterial DNA. However, in these experiments, the uv irradiation dose used (560 erg/mm^2) was sufficient to depress the cellular synthesis of host DNA, while permitting the normal synthesis of phage DNA. DNA synthesis in uv-induced, wild-type lysogens was compared with that of the irradiated nonlysogenic, isogenic control strain and some induced defective lysogens. The early defective lysogens of λ, sus O_3, sus P_3, and T_{11}, were found to synthesize none of the DNA structural intermediates. A lysogen believed to be defective in all known phage activities, λsus N_7, was found to be able to synthesize an early phage DNA intermediate. The lysogen λsus Q_{21}, defective in late phage functions, was able to synthesize the early phage DNA intermediate and a concatenated molecule of greater molecular weight than the mature λ DNA. (BBB)

28363 FREE-RADICAL STATES OF PORPHYRINS AS INTERMEDIATE PRODUCTS AT RADIOLYSIS OF AQUEOUS SOLUTIONS. Amiragova, M. I. Tr. Mosk. Obshchest. Isptyt. Prir., Otd. Biol., 16: 106-8(1966). (In Russian).

From Symposium on Free Radicals Processes in Biological Systems, Moscow. See CONF-640635.

It was discovered that protoporphyrin is reduced reversibly in evacuated aqua-alkaline solutions by the action of ionizing radiation. The yield of this process increases in the presence of ethanol. Changes of the protoporphyrin absorption spectrum indicate formation of two labile reduced forms: tetrahydroporphyrin and hexahydroporphyrin. It is supposed that the joining of solvated electron or H-atom leads to generation of free protoporphyrin radicals. Labile valency-saturated forms of protoporphyrin are generated by the reaction of disproportionation. (auth)

28364 STUDY OF AMINO ACIDS AND PEPTIDES RADIATION CHEMICAL PROPERTIES BY MEANS OF EPR METHOD. Sharpatyi, V. A.; Yanova, K. G.; Ibragimov, A. P. Tr. Mosk. Obshchest. Isptyt. Prir., Otd. Biol., 16: 110-12(1966). (In Russian).

From Symposium on Free Radicals Processes in Biological Systems, Moscow. See CONF-640635.

Radiolysis of amino acids, peptides and their aqueous solutions at low temperatures were studied. Aromatic cycles and heteroatoms (S and O) influence G_R and shape of EPR spectrum in case of amino acid radiolysis. Radicals were generated from amino acid residue when peptid radiolysis took place. The protective effect of phenyl groups and heteroatoms through peptid coupling was not shown. Amino acid and peptid radicals in frozen aqueous solutions were generated by means of their interraction with H and OH radicals. (auth)

28365 HIGH-TEMPERATURE CHANGES OF EPR SPECTRA OF γ-IRRADIATED AMINO ACIDS. Mochalkin, A. I.; Kharitonenkov, I. G. Tr. Mosk. Obshchest. Isptyt. Prir., Otd. Biol., 16: 113-14(1966). (In Russian).

From Symposium on Free Radicals Processes in Biological Systems, Moscow. See CONF-640635.

The changes in the character of EPR spectra of γ-irradiated amino acids under temperatures approximating their melting point were studied. It was suggested that the experimental data indicate the probability of radiation migration along the molecule of amino acid. (auth)

28366 ROLE OF GLYCINE RESIDUA IN LOCALISATION OF RADIATION LESION IN γ-RAYED POLYPEPTIDES AND PROTEINS. Pulatova, M. K. Tr. Mosk. Obshchest. Isptyt. Prir., Otd. Biol., 16: 115-17(1966). (In Russian).

From Symposium on Free Radicals Processes in Biological Systems, Moscow. See CONF-640635.

To define the role of glycine residua in EPR spectra of irradiated polypeptides, both the EPR spectra of polypeptides with and without glycine residua were studied. The EPR spectra's difference in form showed that the relation of the paramagnetic center in the polypeptide chain with a glycine residuum was not necessary. (auth)

28367 PARALLEL STUDIES OF THE RADIATION EFFECT ON FERMENTS BY MEANS OF THE ELECTRON PARAMAGNETIC RESONANCE AND DEFINITION OF THE FERMENTATIVE ACTIVITY. Ganassi, E. E.; Pulatova, M. K. Tr. Mosk. Obshchest. Isptyt. Prir., Otd. Biol., 16: 118-20(1966). (In Russian).

From Symposium on Free Radicals Processes in Biological Systems, Moscow. See CONF-640635.

The quantitative comparison by means of EPR methods of the result of the modifying action of oxygen and heat with the definition of fermentative activity on pepsin has shown that a large quantity of non-coupled electrons generated under the radiation effects is not connected with the biological lesion. The correlation of the whole number of non-coupled electrons and the generation of latent lesions of oxygen and heat types that was observed when the temperature effects of irradiation were studied points to the probable connection of the biological lesion with a part of the visible EPR spectrum. (auth)

28368 STUDY BY MEANS OF EPR STUDIES OF FREE RADICALS, OBTAINED IN SOME BIOLOGICALLY SIGNIFICANT COMPOUNDS WITH THE HELP OF TESL GENERATOR. Golikov, V. P.; Chetverikov, A. G.; Kalmanson, A. E. Tr. Mosk. Obshchest. Isptyt. Prir., Otd. Biol., 16: 134-42(1966). (In Russian).

From Symposium on Free Radicals Processes in Biological Systems, Moscow. See CONF-640635.

Under the influence of high frequency discharge of Tesl generator, ions and electrons that bombard the solid substance placed in the same vacuum volume (T irradiation) arise in the evacuated gas. By means of EPR method free radicals obtained by T irradiation of proteins, peptids, amino acids, nucleic acids, nitrogenous grounds, polysaccharides, saccharobioses and in a number of other organic and inorganic compounds were studied. Free radicals being influenced by the action of T irradiation are similar to free radicals that arise in the same compounds under γ irradiation in the quantity of radical yield and EPR spectra under different influences (temperature, O_2). The relatively low energy of charged particles and the high ionization density connected with this indicate a high efficiency of T irradiation for obtaining the large quantity of free radicals in solid substance. Simplicity, availability and complete radiation safety is another significant quality of the method. The difficulty of surface estimation of solid substance and the absorbed dose are the shortcomings of the method. (auth)

28369 EFFECT OF SMALL WATER CONCENTRATION ON THE CONTENTS OF FREE RADICALS IN NORMAL AND IRRADIATED LYOPHILIZED TISSUES OF WARM-BLOODED ANIMALS. Kharitonenkov, I. G.; Chumakov, V. M.; Trotzenko, V. L.; Kalmanson, A. E. Tr. Mosk. Obshchest. Isptyt. Prir., Otd. Biol., 16: 146-52(1966). (In Russian).

From Symposium on Free Radicals Processes in Biological Systems, Moscow. See CONF-640635.

With the aid of the steam-jet method the EPR spectra of lyophilized organs of rats were studied. Free radicals in tissues denaturated with heat and in tissues taken from the corpses of animals within a 24-hour period were studied. The kinetics of generation and destruction of radicals is practically identical in normal, denaturated and corpse material. The increase of the radicals' concentration is observed only in the presence of O_2, and destruction is determined by the presence of H_2O. It was shown that the humidity of the lyophilization material that has 1.5 to 2% residual humidity may increase only up to 10 to 15%. The speed of radical generation and destruction is determined by the speed of moistening of the sample. The maximum concentration of free radicals does not depend on the speed of moistening. Ionizing radiation brings about partial restoration of radicals. (auth)

28370 EFFECT OF FREE-RADICAL REACTION INHIBITORS ON THE ANTIOXIDATING ACTIVITY OF THE LIPIDS OF MICE LIVER WITH RADIATION DISEASE AND INTERWOVEN LEUCOSIS. Burlakova, E. B.; Dzyuba, N. M.; Pal'mina, N. P. Tr. Mosk. Obshchest. Isptyt. Prir., Otd. Biol., 16: 202-6(1966). (In Russian).

From Symposium on Free Radicals Processes in Biological Systems, Moscow. See CONF-640635.

Antioxidation activity of liver lipids of mice was studied; the activity was decreased by radiation sickness and increased by leukosis. Free radical inhibitors increased or decreased the activity depending on the dose. (H.L.W.)

28371 ELEMENTARY REACTIONS OF SOME RADIOPROTECTIVE SUBSTANCES IN OXIDIZED MODELS. Burlakova, E. B.; Molochkina, E. M.; Khrapova, N. G. Tr. Mosk. Obshchest. Isptyt. Prir., Otd. Biol., 16: 228-31(1966). (In Russian).

From Symposium on Free Radicals Processes in Biological Systems, Moscow. See CONF-640635.

Inhibitors of free radicals and other radioprotective substances, for example cysteamine, are distinguished by their effects on living organisms. The role of radioprotective substances in the oxidation of lipids is discussed. (H.L.W.)

28372 STUDY OF AFTERGLOW MECHANISM OF SERUM ALBUMIN SOLUTIONS, IRRADIATED WITH UV. Sapezhinskii,

I. I.; Silaev, Yu. V.; Dontsova, E. G. Tr. Mosk. Obshchest. Isptyt. Prir., Otd. Biol., 16: 253-7(1966). (In Russian).

From Symposium on Free Radicals Processes in Biological Systems, Moscow. See CONF-640635.

Kinetic regularities of afterglow of serum albumin solutions were investigated. The influence of oxygen on protracted postluminescence in protein solutions was studied. Temperature dependence on postluminescence kinetics, dependence on pH and concentration were determined. The influence of a number of substances including inhibitors of free-radical processes on postluminescence process was examined. On the basis of the calculation of a number of kinetic schemes some suggestions of the postluminescence nature were made. (auth)

28373 NUCLEIC ACIDS IN NORMAL AND γ-RAYS IRRADIATED EGGS OF BOMBYX MORI. Lassota, Zofia (Inst. of Biochemistry and Biophysics, Warsaw). Acta Biochim. Pol., 14: 7-20(1967).

Eggs of the Warska strain of the silkworm were exposed to single doses of 5, 20, or 200 KR from ^{60}Co at a dose rate of 200 KR/min. Normal eggs of B. mori contained at diapause about 0.2 mg of DNA and 3 mg of RNA per 1 g. The DNA content increased about six-fold upon embryogenesis and RNA increased by about 70%, but before hatching fell back the diapausal level. The effects of irradiation at diapause were visible at the postdiapausal period only: 5 KR resulted in delayed DNA synthesis and reduced by 15% the hatching rate; 20 KR delayed the synthesis of DNA, damaged the synthesis of RNA, and inhibited hatching completely; 200 KR stopped the synthesis of DNA and induced the breakdown of RNA. The eggs were less susceptible to 20 KR when irradiated after the peak of RNA synthesis had been attained. The damage of gastrular RNA synthesis was proposed as a probable cause of impaired embryogenesis in 20-KR treated eggs. (BBB)

28374 THE ORIGIN OF THE INCREASED TAURINE EXCRETION IN URINE OF IRRADIATED RATS. Fromageot, Pierre; Boquet, Paul Louis (CEN, Saclay, Gif-sur-Yvette, France). Strahlenschutz Forsch. Prax., 4: 199-230(1964). (In German).

In the rat the amount of excess taurine excreted in urine reached a maximum at doses of 250 to 500 R, amounting to three to five times more than the value in normal unirradiated rat urine. It was detectable after doses as low as 50 R. The increased excretion was probably the result of accumulation of taurine in plasma because of inhibition of processes that normally caused breakdown of taurine. Possible mechanisms of enzymatic activity that could be associated with formation and breakdown of taurine were discussed. Although at present these functions could not be definitely assigned to any enzyme systems known, several possible modes of action of irradiation on a system of this type were outlined. It was proposed that the mechanism of taurine biosynthesis was related to enzymatic biosynthesis of proteins. This hypothesis could be tested by use of radiomimetic drugs. Data were presented comparing effects of irradiation on rats. Irradiation produced enhanced taurine excretion in urine and organs in pyridoxine deficient rats, starved rats, and normal rats with doses up to 800 R, administered at dose rates of ~100 R/min. (References cited, 85). (BBB)

28375 EFFECT OF IONIZING RADIATION ON ATP-ASE ACTIVITY IN THE BRAIN OF MICE. Ghizari, E. Stud. Cercet. Biochim., 10: 137-9(1967). (In Rumanian).

The variation of ATP-ase activity was followed in mouse brains exposed to doses of 12.5 to 500 R x rays at 1, 24, and 48 hours after irradiation. With high x ray doses (500, 250, and 125 R) the enzymatic activity decreased after 24 and 48 hours. Low doses (12, 25, and 50 R) did but slightly affect the enzymatic activity after the same time interval. Both high and low doses did not induce perceptible changes at one hour after irradiation. (auth)

28376 EFFECT OF ^{32}P DECAY UPON RNA TRANSCRIPTION BY A RADIATION-SENSITIVE STRAIN OF ESCHERICHIA COLI. Davern, Cedric I. (Cold Spring Harbor Lab of Quantitative Biology, N. Y.). J. Mol. Biol., 32: 151-4(Feb. 28, 1968).

The effects of lethal ^{32}P decay on the immediate capacity for messenger RNA transcription from the genes specifying the inducible enzymes, β-galactosidase and D-serine deaminase, were measured in a recombinationless strain of Escherichia coli. The results showed that extensive lethal ^{32}P decay had little effect on the capacity of the culture to synthesize either enzyme. The data are compared with results of studies on the inactivation of DNA by ^{32}P decay in this strain of bacteria. (C.H.)

28377 ENZYMORPHOLOGICAL OBSERVATION ON IRRADIATED TUMOR, WITH A PARTICULAR REFERENCE TO ACID HYDROLASE ACTIVITY. I. LIGHT MICROSCOPIC STUDY. Shimosato, Yukio; Watanabe, Keiichi (Keio Univ., Japan). Gann, 58: 541-50(Dec. 1967).

After x irradiation, acid hydrolase activities became diffuse in the cytoplasm. This change clearly contrasted with that occurring in spontaneously degenerating cells and with that in dehydrogenase activities. Radiation effects on the activities of acid hydrolases in tumor cells were discussed in relation to the enzyme release hypothesis. (auth)

28378 RADIATION INACTIVATION OF RIBONUCLEASE. PART II. AMINO ACID COMPOSITION OF IRRADIATION PRODUCTS. Schuessler, Helga; Jung, Horst (Kernforschungszentrum, Karlsruhe, Ger.). Z. Naturforsch., 22: 610-21(June 1967). (In German).

As previously shown ribonuclease irradiated by γ-rays under nitrogen atmosphere may be separated by column chromatography on Sephadex into two components, one having enzymatic activity, the other consisting of aggregated products with less enzymatic activity; in the presence of air an additional inactivated component is formed. Amino acid analysis of these various products shows that in all components methionine, tyrosine, phenylalanine, lysine, and histidine are destroyed with increasing dose, whereas glycine shows a small increase. In nitrogen atmosphere, besides the amino acids mentioned, cystine is changed to a great extent; these changes occur in the active component as well as in the inactivated aggregates. The primary structure of an RNAase molecule may be changed by irradiation without loss of enzymatic activity. After irradiation in nitrogen the main part of the inactivated molecules are present as aggregates, in air a small fraction is converted primarily into denatured monomers which at higher doses show aggregation, too. There are no key amino acids, the alteration of which leads to the inactivation of the enzyme molecule. This conclusion holds in particular for cystine; three independent proofs are presented demonstrating clearly that inactivation of ribonuclease in aqueous solution does not occur by reactive species (generated in the water) attacking the disulphide bridges and converting the molecule from the enzymatically active to the inactivated state. (auth)

28379 SERUM PROTEIN CHANGES IN ACUTE RADIATION DISEASE IN THYMECTOMIZED MICE. Schnelberg, Krzysztof; Koziol-Bartnikowa, Wieslawa; Jonecko, Antoni (Inst. of Oncology, Gliwice, Poland). Arch. Immunol. Ther. Exp., 16: 85-91(1968).

Paper electrophoretic patterns of plasma proteins in mice after whole body irradiation with 500 R of x rays were studied. In some animals total thymectomy was performed one month prior to the irradiation. The characteristic changes in the proteinogram in the course of acute postradiation disease were similar in the thymectomized and control animals, although thymectomy alone caused a ±2% deficiency of γ-globulins in the starting proteinogram. No significant differences were observed between groups of mice which survived and those that died after the operation. It was concluded that the high mortality in mice deprived of the thymus under the conditions of the experiment (as found previously) is not associated with immunity of the humoral type. (auth)

28380 STUDIES ON THE BIOLOGICAL EFFECTIVENESS OF HIGH-ENERGY ELECTRON BEAMS AT DIFFERENT DEPTHS IN TISSUE-ABSORBING MATERIAL. Kim, J. H.; Pinkerton, A.; Laughlin, J. S. (Sloan-Kettering Inst. for Cancer Research, New York). Contract AT(30-1)-910. Radiat. Res., 33: 419-25(1968).

HeLa S-3 cells in culture were used to determine the biological effectiveness of a 20-MeV electron beam at the depths of the relative 100% and 25% dose in a polystyrene phantom. It was found that the survival curves at the two different depths were similar and that the extent of the recovery from sublethal irradiation was not significantly different. The clonal size distribution revealed no qualitative differences between the two depths. It was concluded that the biological effectiveness of 20-MeV electrons at the two depths was not significantly different. The variability in the biological effectiveness observed in some reports with depth resulted from uncertainties in dosimetry or changes in environmental conditions. (auth)

28381 CHANGE IN THE CONCENTRATION OF NON-ESTERIFIED FATTY ACIDS IN THE BLOOD AND THE ANTI-OXIDATIVE ACTIVITY OF LIVER LIPIDS IN MICE OF DIFFERENT LINES IN NORMAL CONDITIONS, IN RADIATION SICKNESS, AND WITH INOCULATED La LEUKAEMIA. Arkhipova, G. V.; Burlakova, E. B.; Terekhova, S. F. (Inst. of Chemical Physics, Moscow). Biophysics (USSR) (Engl. Transl.), 12: 649-53(1967).

Translated from Biofizika, 12: 560-3(1967).

It was established that each of the mouse lines Balb, C_3H, C_3HA, $C_{57}Bl$, and AKR has its own steady level of concentration of non-esterified fatty acids in the blood. The concentration of non-esterified fatty acids in the serum was found to vary inversely with the value of anti-oxidative activity of liver lipids for the

intact mice of the different lines. Changes in the concentration of non-esterified fatty acids in the serum on development of inoculated leukemia in mice and in radiation sickness following exposure to x radiation doses of 450 and 650 R were studied. A complex relation was found between the values of non-esterified fatty acids in the serum and the anti-oxidative activity of liver lipids on development of radiation sickness and inoculated leukemia. (auth)

28382 EFFECT OF THE IONIC STRENGTH OF SOLUTIONS AND SOME OTHER FACTORS ON THE KINETICS ON DENATURING OF DNA ON ULTRAVIOLET IRRADIATION. Zhil'tsova, V. M.; Kruglyakova, K. E.; Gindin, L. G. (Inst. of Chemical Physics, Moscow). Biophysics (USSR) (Engl. Transl.), 12: 614-17(1967).

Translated from Biofizika, 12: 535-7(1967).

The effects of the ionic strength of solution, temperature, and salts of some metals that are stabilizers on the constant of change in the viscosity of uv-irradiated DNA solutions were studied. It was shown that high ionic strength of solution, fall in temperature, and addition of metal salts ($CaCl_2$, $FeSO_4$) lead to a clearcut manifestation of the stepped effect. It was established that low ionic strength of solution leads to disappearance of the stepped character of dependence of fall in viscosity on the concentration of irradiated solution. The findings make plausible the assumption that the stepped effect is due to aggregation of the DNA molecules in solution. (auth)

28383 INFLUENCE OF DEOXYCORTICOSTERONE ACETATE (DOCA), SUPRARENALECTOMY, AND CHRONIC TREATMENT WITH STABLE ZINC ON THE ABSORPTION, DISTRIBUTION, AND EXCRETION OF ^{65}Zn IN WHITE RATS. Pora, Eugen A.; Roventa, Ecaterina; Manciulea, Stefania (Babes-Bolyai Univ., Cluj). Stud. Cercet. Biol., Ser. Zool., 19: 163-9(1967). (In Rumanian).

Following up an earlier study on the effect of DOCA on the incorporation and distribution of intraperitoneally administered ^{65}Zn in various organs of white rats, the effect of DOCA, adrenalectomy and chronic treatment with stable zinc was investigated by a similar method. The hormone was injected intramuscularly in oil at the rate of 5 mg per rat. The results indicated that daily administration of stable zinc for 3 months saturates all of the organs with this element; as a result of this ^{65}Zn was incorporated only very slightly more than usually. Only in the liver was some more ^{65}Zn incorporated because of the high metabolic rate of that organ. DOCA increased the metabolism of ^{65}Zn in the liver, pancreas, muscles, and testicles; the amount of ^{65}Zn transported by the blood and eliminated by urine was also increased while the elimination by feces was decreased. Adrenalectomy resulting in a lack of cortical hormones reduced the zinc metabolism in the pancreas, muscles, and testicles, and increased it in the liver. (TTT)

28384 METABOLISM OF ZINC. I. THE INFLUENCE OF DEOXYCORTICOSTERONE ACETATE (DOCA) ON THE INCORPORATION AND ELIMINATION OF ^{65}Zn IN SOME ORGANS OF WHITE RATS. Roventa, Ecaterina; Pora, E. A.; Manciulea, Stefania (Babes-Bolyai Univ., Cluj). Stud. Cercet. Biol., Ser. Zool., 18: 505-10(1966). (In Rumanian).

Recent studies revealed that ^{65}Zn is distributed preferentially in certain organs, depending on the prevailing conditions. The effect of one of these conditions, the presence of DOCA, was investigated in white rats, sacrificing the animals 1, 2, 3, and 5 days after the injection of the isotope. The hormone was administered at the rate of 5 mg/day intramuscularly for 4 days before introducing the isotope. It was found that DOCA does not affect the accumulation and elimination of ^{65}Zn from the liver, pancreas, and kidneys; at most, a slight increase of the retained amount was noted in the first 3 days after administration. On the other hand, ^{65}Zn is accumulated in the muscles during the first days, reaching a twofold level with respect to the initial one; with DOCA also increased the amount of ^{65}Zn by a factor of 2 with respect to the blank test. The elimination of ^{65}Zn was highest on the third day. (TTT)

28385 ^{237}Pu FOR METABOLIC STUDIES: ITS PREPARATION AND USE. Todd, R.; Logan, R. (United Kingdom Atomic Energy Authority, Annan, Scotland). Int. J. Appl. Radiat. Isotop., 19: 141-5(Feb. 1968).

The suitability of ^{237}Pu for metabolic studies in man is discussed in terms of the yield, purity and radiotoxicity of ^{237}Pu preparations. The sensitivity with which ^{237}Pu can be detected in metabolic studies is indicated. A rapid method of separating ^{237}Pu from cyclotron-irradiated ^{235}U is described. (auth) (UK)

28386 ULTRASTRUCTURAL DEVELOPMENT OF RADIATION INJURY IN HEPATIC PARENCHYMAL CELLS OF γ-IRRADIATED MICE. Hendee, W. R.; Alders, M. A. (Univ. of Colorado, Denver). Lab. Invest., 18: 151-8(Feb. 1968).

Sequential ultrastructural alterations were identified within parenchymal cells of liver tissue fixed from a few seconds beyond 2 minutes to 24 hours after the onset of whole-body γ irradiation of mice to doses between 3,000 and 16,000 rads. Apparent formation of electron-dense annuli from rough surfaced components of the endoplasmic reticulum was noted within cells fixed as early as 2 minutes after the onset of exposure. Other reticulum membranes exhibited tortuous configurations and increased density with equal rapidity. Additional changes observed in cells within tissue fixed at longer postirradiation intervals include dilation of rough surfaced components and proliferation of smooth surfaced constituents of the endoplasmic reticulum; swelling of mitochondrial cristae and disruption of mitochondrial limiting membranes; distention and distortion of the nuclear envelope; and lipid deposition and depleted glycogen. Initial changes in rough surfaced elements of the endoplasmic reticulum, because of the rapidity with which they appear after the onset of exposure, may be closely associated with the initial radiation lesion. Later alterations may be more indicative of general cellular degeneration than specific radiation-induced cell injury. (auth)

28387 COMPARATIVE EFFECT OF IRRADIATION ON THE PROTEIN COMPOSITION OF THE BLOOD SERUM WITH SOURCES WITH DIFFERENT ENERGY. Gol'dberg, E. D.; Matveeva, L. I. Radiobiologiya, 7: 340-2(1967). (In Russian).

Rabbits were irradiated at a dose of 1800 Rad with x rays from a RUM-3 apparatus, with radiation emitted by a 25 MeV betatron, and with radiation emitted by a 30 MeV betatron. In every instance, the content of total proteins, albumins, and γ-globulins decreased in the blood serum of the animals. The severity of the effect on the serum protein composition decreased in the order RUM-3 > 25 MeV betatron > 30 MeV betatron. The tendency towards restoration of the normal protein composition was most pronounced in animals irradiated with the 30 MeV betatron. On irradiation with x rays from the RUM-3 apparatus, tendency towards recovery was not observed; there was a progressive decrease in the total protein, albumin, and γ-globulin content that began on the second day after irradiation. (JPRS)

28388 DECREASE IN THE HETEROGENEITY OF THE DNA-RNA COMPLEX FOLLOWING IRRADIATION. Tokarskaya, V. I. Radiobiologiya, 7: 480-1(1967). (In Russian).

After peas had been moistened in water for 4 hours and subjected to 20 kR of ionizing radiation they were incubated in a medium containing ^{32}P. The RNA-DNA complex containing rapidly labeled RNA was isolated and separated into fractions by chromatography. As indicated by the relative ^{32}P activity of fractions, the synthesis of RNA shifted from RNA of the AU type to that of the GC type as a result of the action of radiation. While the GC peak was practically unaffected, the natural heterogeneity of AU RNA disappeared: a homogeneous peak formed in this region, which corresponded to the synthesis of m-RNA. The results indicated that changes in the matrix synthesis of RNA on DNA had taken place which presumably involved disturbances of DNA coding. (JPRS)

28389 ANALYSIS OF THE ACTION OF SMALL DOSES OF X-RAYS ON DEOXYRIBONUCLEOPROTEINS WITH A DIFFERENT PROTEIN CONTENT. Martynov, E. V.; Spitkovskii, D. M. Radiobiologiya, 7: 315-18(1967). (In Russian).

Nucleoprotein isolated from the calf thymus was subjected to various degrees of deproteinization by the chloroform-butanol method. The deoxyribonucleoproteins (DNP) with a progressively decreasing protein content that were obtained were subjected to irradiation with x rays at doses of 10 to 1000 R. A study of the rheological properties of the DNP before and after irradiation indicated that the sensitivity of DNP to radiation increased with an increasing protein content. The results were consistent with the assumption that radioinduced degradation of high-protein DNP took place mainly by cleavage of intermolecular (inter-strand) bonds formed by protein components, while a different type of bond associated with SH groups was split in low-protein DNP. (JPRS)

28390 RECOVERY ENHANCEMENT OF G_1 AND G_2 MERISTEMATIC CELLS IN EXCISED PEA ROOTS DURING AN INDUCED POSTIRRADIATION STATIONARY PHASE. Van't Hof, Jack (Brookhaven National Lab., Upton, N. Y.). Radiat. Res., 32: 792-803(1967).

Prolonged carbohydrate starvation of sterile excised pea roots induced a stationary phase characterized by the accumulation of meristematic cells in either the G_1 (90%) or G_2 (10%) periods of the mitotic cycle that was relieved by carbohydrate supply. With the presence of carbohydrate, DNA synthesis and mitosis was resumed and the cells returned to a normal mitotic cycle. Three groups of roots were irradiated with 300 R or 600 R of x rays

after 24 hours in the stationary phase, 48 hours in the stationary phase, or 24 hours in the stationary phase followed by another 24 hours in this phase before carbohydrate provision. Three cytological measurements were made: the increase with time in the number of ^{3}H-thymidine-labeled cells, the frequency of mitotic figures, and the appearance of ^{3}H-thymidine-labeled cells in mitosis. Cells in the first and second groups of roots displayed a delay in the increase of ^{3}H-thymidine-labeled cells, an initial reduction of division figures, and a delayed appearance of labeled mitotic figures. The recovery roots, however, displayed only a delayed appearance of labeled mitotic figures. Oxygen consumption measurements indicated the recovery of DNA synthesis, and the onset of cell division took place while metabolism was at a very low level. The overall results demonstrated that retardation of cell division enhanced the recovery rate of DNA synthesis and mitotic delay. (auth)

28391 ANTIBODY SYNTHESIS IN VITRO. VII. ON THE ACTION OF INFORMATIVE RNA MOLECULES IN CELL-FREE SYSTEMS OF SPLEEN CELLS. Jacherts, D. (Medizinische Hochschule, Hanover). Z. Med. Mikrobiol. Immunol., 153: 250-68(Aug. 10, 1967). (In German).

The effect of uv and γ radiation on the informative potential of RNA synthesized in macrophages after antigenic stimulation (informative RNA) was tested. A low-pressure Hg vapor lamp was used as a source of uv radiation. On the basis of the sensitivity to uv and γ radiation, the target size of the informatively active regions in the RNA was estimated. While the informatively active regions on the rapidly sedimenting informative RNA were found to initiate the synthesis of immunologically specific proteins of molecular weights ranging from 150,000 to 170,000, the informatively active regions on the slowly sedimentating fraction coded only for the synthesis of immunologically specific proteins of molecular weights ranging from 29,000 to 40,000. The extent of the informatively active regions suggested that the informative RNA coded for the synthesis of the whole antibody molecule. Results of another experiment showed that in cell-free systems, the immunologically nonspecific parts of the informative RNA inactivated by uv radiation could be replaced by the corresponding parts of a nonirradiated informative RNA of different immunologic specificity. (BBB)

28392 CHANGES IN SPLEEN CELL CFU RADIOSENSITIVITY FOLLOWING TRANSPLANTATION. Muruyama, Y. (Univ. of Minnesota, Minneapolis). Radiology, 90: 353-5(Feb. 1968).

The radiosensitivity of mouse spleen cells capable of forming spleen colonies when injected into heavily irradiated recipients was studied in vitro and in vivo. The density of nucleated cells in single-cell suspensions of mouse spleen was determined before samples were withdrawn for irradiation in vitro or in vivo. Mice of the same strain were exposed to partial-body doses of 610 to 950 rads x radiation before injection of graded numbers of unirradiated spleen cells, after which they were exposed to graded whole-body doses of x radiation to a total dose of 900 to 1000 rads two hours after cell injection. In vitro radiosensitivity was determined by cell irradiation before injection into heavily irradiated recipients. Spleen cell colony forming capability was found to be more radiosensitive when cells were irradiated in vitro than when irradiation was in vivo. The transition of radiosensitivity was studied in cells injected into recipient animals that were exposed to a whole-body dose of 185 rads x radiation at various times following injection of the cells. Results indicated that the radiosensitivity of spleen cell colony forming capability is not constant in the early period following transplantation but passes through multiple states. This suggests a variety of sensitive states for the colony-forming cell of the spleen, rather than a single, constant radiosensitivity state. (C.H.)

28393 NEW DATA ON ACCUMULATION OF ^{35}S AND ^{106}Ru BY DRAGONFLY NYMPHS (ODONATA). Getsova, A. B.; Volkova, G. A. (Zoological Inst., Leningrad). Entomol. Rev. (USSR) (Engl. Transl.), 46: 38(Jan.-Mar. 1967).

A relation between radioisotope accumulation and the age of the larva was noted in previous reports on the accumulation of various elements by mosquitoes and caddis flies. Young instar larvae accumulated radioisotopes more intensively than late instar larvae. Experiments on the accumulation of ^{35}S and ^{106}Ru by various instars of the dragonfly, Aeschna grandis, are reported here. The first group comprised young instars in the first year of development, while the second comprised nymphs in the last two development stages. Data on the concentration factors of ^{35}S and ^{106}Ru (the ratio of the concentration of the radioisotope in the organism and in the surrounding medium) for dragonfly nymphs of the various instars are presented in tabular form. It was evident that concentration was related to the instar. Both ^{35}S and ^{106}Ru were accumulated considerably more by the young instars than by the late instars. The difference in concentration was noted not merely at a single point, but throughout the duration of the experiment; it was most pronounced for ^{35}S. (BBB)

28394 TRANSMISSION OF A HIGH-POWER RUBY LASER BEAM THROUGH BONE. Hoegberg, Lars; Stahle, Jan; Vogel, Klaus (Univ. Hospital, Uppsala). Acta Soc. Med. Upsal., 72: 223-8(1967).

Interaction of laser radiation with bone was examined by studying the energy transmittance and scattering of a Q-switched ruby-laser pulse (power density 4×10^{10} W/cm^2) during its passage through bone slices 0.3 to 1.0 mm thick. Transmittance was measured by a rat's-nest bolometer, and scattering was visualized by passing the laser beam through a colloidal solution. Between 15 and 25% of the pulse energy was transmitted through the bone slices without causing perforation. At the impact point of the laser pulse (energy 0.6 J) evaporation of the bone, resulting in a small white spot, was observed. Perforation or splintering of the bone never occurred. Although part of the beam passed through the bone slice without scattering, the power density was greatly affected by the scattering and damage could thus be expected, mainly in the immediate vicinity of the scattering bone layer. These results agreed with previous measurements of burns on photographic film. The maximal biological effect could be expected at the impact point of the main beam. Possibilities of using laser pulses for producing small selective lesions in the inner ear were discussed. (BBB)

Ecology

Refer also to abstracts 27916, 28271, 28447, 28487, 28628, and 29271.

28395 (TID-23939) SOME ECOLOGICAL ASPECTS OF NUCLEAR WAR. Eberhardt, L. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Apr. 1967. 31p. (TAB-R-7). Dep. CFSTI.

A review of the literature on ecological aspects of nuclear war is presented. Statements are quoted from the literature concerning assessment of long-term ecological effects such as disruption of the balance of nature, changes in climate, water, and food supply, outbreaks of disease and pests, and effects of fire, flood, and erosion. Detailed studies of postattack problems of diseases, radiation effects on plants and animals, and hazards of wildland fire are reviewed. Difficulties of predicting the ecological effects of a nuclear attack are pointed out. In addition to the lack of relevant data, the inadequacies of current technology for modeling ecological phenomena, and the complex of interactions possible in any natural system increase the difficulties of making predictions. Problems pertinent to understanding pest control are reviewed. Studies on pest control are of two types: species-directed approach and system-directed approach. The species approach assumes that other species and factors either hold reasonably constant in number or have no major influence on the species of interest. The systems approach is concerned with interrelationships between species and an understanding of natural processes maintaining population stability. A list of 56 references is included. (H.L.W.)

28396 RADIOECOLOGICAL INVESTIGATIONS IN SEAS AND OCEANS. Polikarpov, G. G. (Inst. of Biology of the Southern Seas, Sevastopol, USSR). Radiobiologiya, 7: 801-12(1967). (In Russian).

A report on recent activity in the subject area, mainly as reflected in the proceedings of recent symposia and congresses, is given. (JPRS)

Genetics and Cytogenetics

Refer also to abstracts 28462, 28574, 28575, 28597, 28617, 28628, 28630, 28666, and 28722.

28397 (ANL-7278, pp 144-69) RADIATION GENETICS. (Argonne National Lab., Ill.).

MICE—radioinduced mutations in, for sex-linked recessive lethals and visible autosomal genes, rate of; relation of abnormality of aorta of, to sex-linked lethal gene; radiation effects on fitness of, combined effects of genetic stress on background x; radiosensitivity of catalase in, effects of mutations on; sensitivity to γ and x radiation, hydrogen peroxide, and inhalation of oxygen, effects of mutations on; distribution of catalase and uricase in liver of, effects of mutations on; analysis of catalase mutations in, for linkage relationships

PROTEINS—genetic variations in Bence-Jones; comparison of light chain of myeloma, with λ-type Bence-Jones; syn-

thesis in developing frog eggs, effects of pituitary hormones on
CHROMOSOMES—analysis of rat, by use of computers and optical scanners
SCHIZOMYCOTA—Escherichia coli, synthesis of DNA in cultures of, in relation to mitotic cycle; Escherichia coli, mutations induced by caffeine, effects of far red light on rate of; Escherichia coli, mutations induced in, by black light; Escherichia coli, mutations induced in cultures of, by light, effects of wavelength on; Escherichia coli, radiation effects on parent and recombinant strains of, x
MUTATIONS—radioinduced, in Drosophila, effects of female germ cell exposure on neutron and x (H.L.W.)

28398 (NYO-2147-13, pp 95-102) COMPARISON OF RADIATION-INDUCED CHROMATID ABERRATIONS IN THE TESTES AND BONE MARROW OF CHINESE HAMSTER. Brooks, A. L.; Lengemann, F. W. (New York State Veterinary Coll., Ithaca. Dept. of Physical Biology).

In research upon radioinduced mutations, chromosome aberrations present in somatic tissues are used as an index of the genetic damage to the animal organism. Little is known about the relation of damage produced in a somatic tissue to that produced in a reproductive tissue. The purpose of this work was to compare the chromatid breaks of testicular tissue to that of bone marrow in the Chinese Hamster. The results indicated that at six hours after irradiation the testicular cells showed twice as many chromatid breaks as did the bone marrow. A time study indicated that differences were maximum at early time intervals and approached unity at 24 hours. The data suggest that the damage observed in one tissue can not be extrapolated to another and that characterizing the sensitivity of chromosomes requires a collection over several different time periods. (auth)

28399 (ORNL-4100, pp 40-7) CYTOLOGY AND GENETICS. (Oak Ridge National Lab., Tenn.).
PHOTOREACTIVATION—effects of pyrimidine dimers in DNA of Paramecium aurelia
ULTRAVIOLET RADIATION—effects of DNA of Paramecium aurelia; effects on Tetrahymena pyriformis, repair of
THYMINE—radioinduced dimerization of, in Tetrahymena, uv
PROTOZOA—Tetrahymena pyriformis, carbonhydrate content of, cyclic variation in alcohol-soluble
NUCLEOTIDES—binding to photoreactivating enzyme
TRANSFERASES—use in preparation of nucleotides from thymus gland
ENZYMES—relation of photoreactivating to cytochrome in yeast
FRUCTOFURANOSIDASE—content of yeast during stationary and logarithmic growth
ALCOHOL DEHYDROGENASE—content of yeast during stationary and logarithmic growth
SCHIZOMYCOTA—Escherichia coli, localization of photoreactivating enzyme in
INSECTA—Rhynchosciara sp., development of puffs in chromosomes of; Sciara ocellaris, heterozygocity of chromsomes in
MICE—identification of Rho and R antigens in
NUCLEIC ACID—synthesis in polytene chromosomes of Rhynchosciara (H.L.W.)

28400 (ORNL-4100, pp 48-53) FUNGAL GENETICS. (Oak Ridge National Lab., Tenn.).
EUMYCOTA—Neurospora sp., radioinduced mutations in, x
ENZYMES—development of assays for, in Neurospora mutants
PHOTOREACTIVATION—effects on uv-radioinduced inactivation of Neurospora conidia
MUTATIONS—analysis of revertants in Neurospora (H.L.W.)

28401 (ORNL-4100, pp 54-61) DROSOPHILA CYTOLOGY AND GENETICS. (Oak Ridge National Lab., Tenn.).
CHROMOSOMES—recombination in oocytes of Drosophila, effects of temperature on; aberrations in Drosophila, determination of meiotic; structure of Drosophila, in relation to crossing over; radioinduced fragmentation of Drosophila, analysis of, for duplication; recombination in Drosophila, effects of translocation on
INSECTA—Drosophila sp., recombination in oocytes of, effects of temperature on; Drosophila sp., behavior of x chromosomes in female
AUTORODIOGRAPHY—performance for determinations of uptake of tritium-labeled thymidine by oocytes of Drosophila
MEIOSIS—development of mutants affecting, in Drosophila
ALCOHOL DEHYDROGENASE—content of Drosophila, selection of loss mutations for
X RADIATION—effects on genes determining enzyme activity in Drosophila
MUTATIONS—determination of meiotic, in Drosophila (H.L.W.)

28402 (ORNL-4100, pp 62-9) YEAST, HYMENOPTERA, AND PHAGE GENETICS. (Oak Ridge National Lab., Tenn.).
EUMYCOTA—Saccharomyces sp., mutations in, reversion rates for, during meiosis and mitosis
XANTHINE OXIDASE—analysis of electrophoretic patterns of, in Habrobracon
INSECTA—Habrobracon juglandis, metabolism of xanthine dehydrogenase; Habrobracon serinopae, metabolism of xanthine dehydrogenase in; Habrobracon spp., analysis of intersex mutations in
ULTRAVIOLET RADIATION—effects on chromosomes of amphibia
NUCLEIC ACID, DEOXYRIBO—analysis of priming activity of, in chromosomes of amphibia
AMPHIBIA—Triturus viridescens, radiation effects on chromosomes of, uv
RIBONUCLEASE—effects on growth of chick embryos (H.L.W.)

28403 (ORNL-4100, pp 70-4) HUMAN CYTOGENETICS. (Oak Ridge National Lab., Tenn.).
CHROMOSOMES—radioinduced aberrations of, in human leukocytes; radioinduced aberrations of, in human leukocytes following therapy
LEUKOCYTES—radioinduced aberrations in cultured human, x
ULTRAVIOLET RADIATION—effects on thymine dimers in human cell cultures
CELLS—radioinduced thymine dimers in cultured human, uv
MAN—radiation effects on chromosomes in, x (H.L.W.)

28404 (ORNL-4100, pp 97-103) RADIATION MICROBIOLOGY AND MICROBIAL GENETICS. (Oak Ridge National Lab., Tenn.).
SCHIZOMYCOTA—Escherichia coli, radiation effects on, effects of cell size on x; Escherichia coli, mutations induced in, by triethylene melamine; Escherichia coli, isolation of cell division mutants in; Escherichia coli, energy metabolism and requirements for pair formation during conjugation of; Escherichia coli, synthesis of DNA and proteins during conjugation of; Escherichia coli, localization of genes and mechanisms for transfer of chromosomes in
EUMYCOTA—Neurospora crassa, radiation effects on, protective effects of acridine dyes against uv (E.R.B.)

28405 (ORNL-4100, pp 110-16) MAMMALIAN GENETICS. (Oak Ridge National Lab., Tenn.).
MICE—radiation effects on frequency of mutations in, effects of interval between exposure and conception on x; mutations induced in male, by EMS and nitrosoguanidine; analysis of linkage groups in chromosomes of; uptake of tritium-labeled uridine by oocytes of (E.R.B.)

28406 (ORNL-4100, pp 202-6) COOPERATIVE PROGRAMS: AEC-NASA SPACE BIOLOGY. (Oak Ridge National Lab., Tenn.).
EUMYCOTA—Neurospora crassa, radiation effects on, combined effects of weightlessness on β; Neurospora crassa, radiation effects on, during space flight, γ; Neurospora crassa, radioinduced aberrations of chromosomes in, combined effects of space flight on β
INSECTA—Habrobracon sp., radiation effects on dominant lethality and survival of, during simulated space flight, β (H.L.W.)

28407 (ORO-2575-41) STUDIES OF EARLY EFFECTS OF RADIATION ON CHROMOSOMES AND MITOSIS. Annual Progress Report, March 1, 1967-February 29, 1968. Carlson, J. Gordon (Tennessee Univ., Knoxville. Inst. of Radiation Biology). Contract AT(40-1)-2575. 6p. Dep. CFSTI.

Effects of monochromatic ultraviolet radiation on mitosis in the neuroblast cells of the grasshopper, Chortophaga viridifisciata, were studied. Other studies were conducted on the effects of ultraviolet on the incorporation of tritium-labeled thymidine in the nucleus of the neuroblast cell. A comparative study was done on x-ray-induced prophase reversion in different kinds of cells of grasshoppers, birds, and mammals. Intracellular retention of tritium-labeled thymidine between periods of DNA synthesis was investigated. Studies on the interdependence of RNA, DNA, and protein synthesis and mitosis in the grasshopper neuroblast included determination of the effect of actinomycin D on RNA and DNA synthesis, autoradiographic studies of tritium-labeled amino acid uptake, and the action of puromycin dihydrochloride on protein synthesis and mitosis. Oocytes of Rana pipiens were used for studies on the site of synthesis of DNA, RNA, and proteins and their movements through nuclear pores. The action of 5-fluorodeoxyuridine on the grasshopper neuroblast was investigated. It was found that the grasshopper eggs were parasitized by larvae of a wasp, Scelio bisulcus. (H.L.W.)

28408 OBSERVATIONS ON CHROMOSOMAL ABERRATIONS INDUCED BY X-RAY THERAPY. Gripenberg, Ulla (Univ. of Helsinki). Ann. Acad. Sci. Fenn., Ser. A IV, No. 109, 34p(1967).

Cell damage was examined in leukocyte populations from ten patients surgically treated for malignant tumors and subsequently given x ray therapy at high dosage. In 26% (8 to 35%) of the cells from these patients, structural changes were observed. In two cases an obvious increase in the proportion of aneuploid cells was found. The frequency of polyploid cells was increased in four cases. The fact that the observed frequency of damaged cells represented a minimum was emphasized. Observations regarding clumping of chromatin and despiralization were also reported. Two series revealed several cells with identical abnormal chromosomes suggesting clone formation, although the number of abnormal cells was too low to permit definite conclusions. In total, 121 abnormal cells from the ten patients were analyzed in detail. Types and relative frequencies of structural changes were accounted for. Multiple structural changes were found in a considerable proportion of the cells. The reconstruction of karyotypes was unsuccessful in many of the abnormal cells for reasons which were explained. The elimination of chromosomes in the karyogram was found to be nonrandom. The large chromosomes two, three, and B were eliminated more frequently than expected from their relative lengths. Chromosome one seemed to be comparatively resistant to structural changes. The polyploid cells showed a high frequency of abnormal chromosomes. (BBB)

28409 GENETIC CLASSIFICATION OF CERTAIN SPORULATION MUTANTS OF BACILLUS SUBTILIS, MARBURG. Rouyard, Jean-Francois; Ionesco, Helene; Schaeffer, Pierre (Institut Pasteur, Paris). Ann. Inst. Pasteur, 113: 675-83(Nov. 1967). (In French).

Eleven uv-radiation-induced sporulation mutants of the strain 168 (try^-) were isolated and their properties described. In addition to the uv mutants, 1 spontaneous and 1 proflavine-induced mutants were also characterized. Ultraviolet radiation was used as a mutagen in doses aimed at attaining a survival rate of 10^{-3}. From crosses carried out by transformation between mutants blocked at stage II or III of sporulation, some conclusions were drawn. Genetic linkage was observed in some cases between mutants blocked at the same stage, but not all such mutants were linked to each other. At least 4 unlinked loci controlling the passage from stage II to III could be detected, and at least 5 controlling the passage from stage III to IV. No genetic linkage could be detected between mutants blocked at clearly different stages of sporulation. Thus, there was a relation between the stage of sporulation at which mutation will cause a block and the genetic location of the mutation. Of 2 closely linked mutants blocked at the same stage, one may be asporogenous and the other oligosporogenous; stage II mutants, while allelic, may differ in the number of the spore septa they will form. (BBB)

28410 CHROMOSOME ABERRATION AND MITOTIC DEATH IN X-IRRADIATED HeLa CELLS. Terasima, Toyozo; Ohara, Hiroshi (National Inst. of Radiological Sciences, Chiba, Japan). Mutat. Res., 5: 195-7(Jan.-Feb. 1968).

An attempt was made to test the aberration hypothesis of radiation lethality. Since sensitivity to lethal damage varies during the cell cycle, investigation of the effects of cell stage on the frequency of radioinduced chromosome aberrations should indicate the relation between aberrations and cell survival. Synchronized HeLa cells were x-irradiated (500 R) during the G_1 stage of the cell cycle. Survival of cells irradiated during the early (3 hr) G_1 period was four times higher than cells irradiated late (8 hr) in the G_1 stage. Total chromosome aberration frequencies per cell irradiated at the two times were equal. However, dicentric and ring chromosomes were more frequent in those cells irradiated at 3 hr than at 8 hr. It would appear that types of cell damage other than chromosome aberration play a predominant role in causing cell death. (M.M.B.)

28411 LOWERING EFFECT OF DOSE-FRACTIONATION ON RECESSIVE LETHAL FREQUENCIES IN DROSOPHILA SPERMATOCYTES. Tates, A. D. (Univ. of Leiden). Mutat. Res., 5: 109-16(Jan.-Feb. 1968).

The effect of dose-fractionation on the induction of sex-linked recessive lethals in a ring-X chromosome was studied in the different stages of spermatogenesis of Drosophila melanogaster. The fractionated dose was given in five fractions at 2-h intervals. In some experiments the fractionation was combined with pre- or post-treatments with nitrogen or oxygen. In cells presumably corresponding to spermatocytes dose-fractionation resulted in a significant decrease of the mutation frequency. The fractionation effect in spermatocytes was also significant when dose-fractionation was combined with pre- or post-treatments with nitrogen. As the most likely interpretation for the fractionation effect, it is presumed that the acute and fractionated radiation differentially affect a process of cell selection. (auth)

28412 ABSENCE OF APPARENT DARK RECOVERY FROM THE PHOTODYNAMICALLY-INDUCED MUTATIONAL DAMAGES IN YEAST CELLS. Ito, Takashi; Hieda, Kotaro (Tokyo Univ.). Mutat. Res., 5: 184-6(Jan.-Feb. 1968).

Dark recovery from photodynamically-induced lethal and mutational damage was tested for in diploid (ad^+/ad^-) Saccharomyces cerevisiae. Cells stained with acridine orange ($2.28 \cdot 10^{-5}$ M) in aqueous suspension for 1 hr were illuminated with a fluorescent lamp in a quartz cell. Other cells were exposed to ultraviolet light alone or in combination with photodynamic action. Testing for mutation at the adenine locus or for survival was done either immediately or after storage up to 25 hr. The data do not reveal dark repair of either lethal or mutational damage induced by photodynamic action although both occurred in the stored ultraviolet-treated cells. (M.M.B.)

28413 MUTATIONS IN PEAS INDUCED BY DIETHYLSULPHATE AND X-RAYS. Monti, L. M. (CSN, Rome). Mutat. Res., 5: 187-91(Jan.-Feb. 1968).

The reliability of the chlorophyll mutation test for comparing mutagenic agents was investigated. Dry seeds of Pisum plants were exposed to either diethylsulfate (DS) or x radiation. Seedlings from the treated seeds were classified according to the degree of damage as judged from height and leaf spotting and mutations were scored. Progeny were grown from the main stem and branches of each plant and analyzed for mutants. Diethylsulfate is three to four times more effective than x radiation when either morphological or chlorophyll mutations or both are considered. About ½ of the mutations induced by either agent were morphological mutants; of these, DS induced a higher frequency of mutations affecting waxiness and flower characteristics and a lower frequency affecting leaf morphology and seed setting, as compared to x radiation. After DS treatment the higher the damage in the seedling the higher was the mutation frequency. A relation between damage and mutation frequency did not appear to occur after x irradiation, although the progeny of the least injured seedlings exhibited the lowest mutation frequency. The chlorophyll mutation was shown to be reliable for comparison of mutagenic agents. (M.M.B.)

28414 ADDITIVE EFFECT OF X-RAYS AND MALEIC HYDRAZIDE IN INDUCING CHROMOSOMAL ABERRATIONS AT DIFFERENT STAGES OF THE MITOTIC CYCLE IN VICIA FABA. Scott, D. (Medical Research Council, Harwell, Eng.). Mutat. Res., 5: 65-92(Jan.-Feb. 1968).

In contrast to the lesions induced by x rays, those induced by certain radiomimetic chemicals require the intervention of chromosome replication (or DNA synthesis) before they can be converted to chromosomal aberrations observable at mitosis. An experiment was performed to determine whether or not such lesions are able to interact with one another in the formation of aberrations. Vicia faba roots were treated with x rays, maleic hydrazide (MH), or x rays + MH. Tritium-labeled thymidine autoradiography was used as a marker for the mitotic cycle. The results indicated that, after the combined x ray/MH treatment, the frequency of all types of chromosomal aberrations, at all stages of the mitotic cycle, was merely the sum of the frequencies induced by x rays and MH when given separately. No evidence was obtained of any interaction between lesions induced by these two agents. It is suggested that there is a temporal barrier to interaction, since the times, after treatment, when the lesions induced by these two agents are available for interaction, do not coincide. (auth)

28415 EFFECT OF X RAYS ON FEMALE GERM CELLS OF DROSOPHILA MELANOGASTER. III. A COMPARISON WITH HEAT-TREATMENT ON CROSSING-OVER IN THE X-CHROMOSOME. Chandley, Ann C. (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Mutat. Res., 5: 93-107(Jan.-Feb. 1968).

Crossing-over in the X-chromosome of Drosophila melanogaster was studied following x ray doses of 2000 to 8000 rad and high temperature treatment at 34°C. Crossing-over was increased in the proximal regions adjacent to the centromere and decreased at the distal end by heat and by all x ray doses. The responses produced by heat-treatment and 2000 rad x rays are similar in several respects. There was a 3-day hypersensitive period during which eggs showed maximum sensitivity to induced changes at both ends of the chromosome. These were believed to be eggs that were oocytes in DNA-synthesis at the time of treatment. Oogonia and stem-cells were less sensitive but did show significant changes in crossing-over at both ends of the chromosome at the higher x ray doses. It was thought that synapsis for meiotic exchange was disrupted in early oocytes and maximum reduction of distal

crossing-over was thereby produced. In oogonia, mitotic pairing was disrupted and this indirectly reduced synapsis at meiosis. There was some evidence that distal crossing-over be reduced when prophase oocytes were treated. It was suggested that crossing-over may normally take place over an extended period from interphase to prophase of meiosis. (auth)

28416 DIFFERENTIAL EFFECTS OF CAFFEINE IN MUTAGEN-TREATED SCHIZOSACCHAROMYCES POMBE. Clarke, C. H. (Inst. of Animal Genetics, Edinburgh). Mutat. Res., 5: 33-40(Jan.-Feb. 1968).

In the haploid fission yeast Schizosaccharomyces pombe, caffeine supplementation of the plating medium leads to a decreased survival following uv irradiation. In a $met^- \rightarrow met^+$ reversion system in which the revertants are due to suppressor mutations there is a differential enhancement of lethality and of met^+ reversions by caffeine. This result may mean that potentially lethal and potentially mutagenic lesions are different. They could differ either in their chemical nature, or in their accessibility to a caffeine-sensitive dark-repair system. Caffeine is without any obvious effect on the lethality and met^+ reversions induced by nitrous acid or nitrosomethylurethane treatments. This suggests that the caffeine-sensitive dark-repair system is specific for only some types of lesions. (auth)

28417 SENSITIVITY OF DROSOPHILA (DROSOPHILA MELANOGASTER MEIG.) EGGS TO LETHAL ACTION OF ULTRAVIOLET RAYS. II. GENETIC DETERMINATION OF THE SENSITIVITY OF EMBRYONIC STAGES POSTERIOR TO GASTRULATION. Ghelelovitch, S. (Laboratoire Pasteur de l'Institut du Radium, Paris). Mutat. Res., 5: 117-31(Jan.-Feb. 1968). (In French).

The uv radiosensitivity of the post-gastrular stages of Drosophila embryos does not depend on their genotypic constitution but on the origin of their cytoplasm. The cytoplasmic sensitivity factor is not a self-replicating factor. Its presence in the egg is determined during oogenesis by the genotype of the mother. The sensitivity character is hereditary and transmitted with the second chromosome. Crossing-over between two homologous chromosomes of different origin changes the degree of sensitivity that each of them determines. It was impossible to localize the genes determining sensitivity. They may be numerous and dispersed all along the second chromosome. Their individual effects are small, and not always additive. The nature of the cytoplasmic sensitivity factor is discussed. (auth)

28418 EFFECTS OF ACUTE SINGLE OR FRACTIONATED X-RAY TREATMENT ON MOUSE SPERMATOGONIA. Sheridan, William (Lab. of Radiation Genetics, Stockholm). Mutat. Res., 5: 163-72(Jan.-Feb. 1968).

Male CBA mice were irradiated with a total x-ray dose of 275 R delivered to their spermatogonia in 55 daily fractions of 5 R each. A second group received 275 R in one acute dose, and a control group was not irradiated. Dominant lethality among the offspring (measured as intra-uterine death) occurred at a significantly higher rate when the parent received a single acute dose than when the parent was either fractionally irradiated or a control. F_1 females from the irradiated groups showed no significant effects on productivity or fertility when compared to the control. There were no indications of increased mutation rates for sex-linked recessives among offspring to either irradiated group. Investigation of the rates of intra-uterine death in back-crosses between F_1 males and their F_2 daughters did not reveal any significant increase in the frequency of recessive lethals in the irradiation groups as compared to the control. This indicates that the rates of induction of recessive lethals are quite low. It was concluded that there was no evidence that the administration of an irradiation dose in many small fractions leads to an increased mutation frequency. (auth)

28419 DEFECTIVE MAMMALIAN CELLS ISOLATED FROM X-IRRADIATED CULTURES. Todd, Paul (Univ. of California, Berkeley). Mutat. Res., 5: 173-83(Jan.-Feb. 1968).

Cultures of mammalian cells exposed to ionizing radiations gave rise to a large proportion of surviving cells that expressed radiation injury in an heritable manner, in that isolated progeny of irradiated cells that gave rise to abnormally small colonies were found to grow more slowly and were more sensitive to further irradiation. Such inherited injury occurred in irradiated human as well as hamster cell lines. In two defective cell lines investigated, the enhanced radiation sensitivity was accompanied by reduced oxygen consumption. Defective Chinese hamster cell lines could exist with no visible gross alterations in karotype. The frequency of small colony appearance in irradiated normal cultures increased regularly with dose, and the frequency with which they were produced was apparently too great to be due to single-gene mutations. (auth)

28420 COMPARISON OF ETHYL METHANESULFONATE- AND RADIATION-INDUCED WAXY MUTANTS IN MAIZE. Amano, Etsuo (National Inst. of Genetics, Misima, Japan). Mutat. Res., 5: 41-6(Jan.-Feb. 1968).

Three fast neutron and nine ethyl methanesulfonate (EMS)-induced waxy (wx) mutants of maize were compared with regard to differences in the type of accompanying genetic alterations. Pollen grain analysis of F_1 hybrids between the induced wx mutants and a tester wx stock revealed in radiation-induced mutants an absence of, or very few non-waxy (Wx) pollen grains. However, most of the EMS-induced mutants produced Wx pollen grains at a higher frequency in the F_1 hybrids, suggesting that there was less cytogenetic damage than with neutrons. The results of segregation tests with a linked marker gene in the selfed progenies of the mutant-tester hybrids supported this in that there was a lower survival of a marker gene C^I, that was linked to the radiation-induced wx genes, whereas the EMS-induced mutants showed normal segregation of the marker gene. (auth)

28421 CHROMATID ABERRATIONS IN TRADESCANTIA BRACTEATA AND A FURTHER TEST OF REVELL'S HYPOTHESIS. Savage, J. R. K.; Preston, R. J.; Neary, G. J. (Medical Research Council, Harwell, Eng.). Mutat. Res., 5: 47-56(Jan.-Feb. 1968).

Data for chromatid aberrations induced in the pollen grain generative nucleus of Tradescantia bracteata and Tradescantia paludosa by a variety of radiations were analysed from the point of view of Revell's exchange hypothesis. The two test ratios: Ratio I: chromatid breaks (i.e., true discontinuities): incomplete isochromatid aberrations and Ratio II: total "minutes"; total isochromatid aberrations, were in satisfactory agreement with expectation. There was no evidence of an excess of "breaks". The data show a correlation between the ratios ($r = 0.76$) indicating a relation between true "breaks" and intrachanges, and the agreement between the observed and predicted slopes strongly suggests that this relation is of the type that Revell originally proposed. The only exception was the α-particle data, and here failure to conform arose because the increased incompleteness that occurred with these high LET particles, was confined almost entirely to type 4 (isochromatid) intrachanges. The results are in good agreement with findings in Vicia faba, and rule out intrinsic species differences as a possible explanation for the high frequency of chromatid "breaks" found in Tradescantia paludosa. (auth)

28422 RADIOSENSITIVITY OF OOGONIA AND OOCYTES IN THE FOETAL AND NEONATAL MONKEY. Baker, T. G.; Beaumont, Heather M. (Univ. of Birmingham, Eng.). Nature (London), 214: 981-3(June 3, 1967).

The studies described indicated that germ cells in developing female monkeys are considerably more resistant to radiation-induced cell death than those at equivalent stages of gametogenesis in rats and mice. (auth)

28423 GENETIC EFFECTS OF CHRONIC GAMMA IRRADIATION IN DURUM WHEAT. Donini, B. (National Committee for Nuclear Research, Rome); Scarascia Mugnozza, G. T.; D'Amato, F. Radiat. Bot., 8: 49-58(Feb. 1968).

Three cultivars of durum wheat, Cappelli, Aziziah and Russello, and a radiation induced stable mutant of Cappelli, brachytic, were subjected to chronic γ-irradiation from ^{60}Co for their whole life cycle (from the 3-leaf stage to harvest). Radiation exposures of 5, 10, 15, 20, 25, and 30 R/20-hr day were applied. Mature spikes were harvested from the irradiated plants, keeping spikes produced by the main culms ("main spikes") separate from those produced by tillers "secondary spikes". Both spikelet fertility and germination of caryopses decreased with increasing exposure rate. In the first generation from irradiated plants no case of chlorophyll mutation was found. In the second generation chlorophyll mutations were found in two categories of plants: (a) plants heterozygous for the mutation (all spikes segregating for the mutation), and (b) plants chimeric for the mutation (segregation for mutants occurring in one or two—but not all—spikes). The two types of mutations occurred with a frequency of 20 and 80 per cent, respectively. This shows that, in durum wheat plants irradiated for their whole life cycle, the majority of recoverable mutations are induced in the post-fertilization diplophase, i.e., during development and maturation of the embryos. Seventy-two out of 78 of the mutations occurring in chimeric plants of Cappelli and Aziziah were found in the progeny of the "main" spikes of irradiated plants. The possible reasons for this striking difference between "main" and "secondary" spikes in undergoing mutation during embryogenesis are discussed. A great variation in response to genetic effects of radiation among the four types of durum wheat tested was found. It was ascribed to different characteristics of their life cycle rather than to differences in radiation sensitivity. (auth) (UK)

28424 SOMATIC ABERRATIONS IN SOLANUM TUBEROSUM INDUCED BY ETHYL METHANE SULFONATE AND X-IRRADIATION. Umaerus, Magnhild. Hereditas, 57: 447-8 (1967).

Potatoes were treated with EMS and x radiation, and effects of these treatments were compared. EMS treatment allowed a more normal development of the plants than did x radiation. The tubers formed after x radiation were often very small and gave rise to weak plants that made identification of aberrations difficult. On the other hand, x-irradiated material is more easily handled. Changes in tendency to discoloration of the raw potato and in tendency of the tubers to accumulate reducing sugars were found after both kinds of treatment. A direct comparison of aberration rates could not be made. (auth) (TSS)

28425 CHROMOSOME ANALYSIS OF AN INFANT AFTER INTRAUTERINE IRRADIATION. Kucerova, Maria (Inst. of Experimental Biology and Genetics, Prague). Acta Radiol., Ther., Phys., Biol., 6: 410-13(Oct. 1967).

Intrauterine x irradiation in the fifth and sixth months of pregnancy induced a highly significant increase in the percentage of aberrant mitoses in the peripheral leukocytes of an infant as detected 14 months later. The percentage of aberrant mitoses in the mother 15 months after the irradiation was nearly the same as in the child. (auth)

28426 MUTATIONS PRODUCED BY TRANSMUTATION OF ^{32}P TO ^{32}S WITH IN DROSOPHILA DNA. Lee, William R.; Sega, Gary A.; Alford, Carolyn F. (Univ. of Texas, Austin). Proc. Nat. Acad. Sci., U. S., 58: 1472-9(Oct. 1967).

Evidence is presented that transmutation of ^{32}P to ^{32}S within the DNA molecule of Drosophila spermatozoa produces lethal mutations that are detected only in the F_3. If the delay in expression of the lethal mutation is due to F_1 mosaicism, the mutant cells must average 25% or less of the F_1 mosaic fly, or otherwise a significant fraction of the lethals will be detected in the F_2. Mosaics of 25% or less may be the result of multistrandedness or the mechanism of mutation. Regardless of which explanation may be correct, it is clear that the conventional explanation for the origin of mosaics by the alteration of one strand of double-stranded DNA to produce a cell lineage with half mutant and half nonmutant cells cannot be applied to these mutations induced by transmutation of ^{32}P to ^{32}S. The implications for estimating genetic damage from radionuclides incorporated into DNA must be reevaluated in view of these results. Furthermore, these results indicate the inadequacy of conventional F_2 lethal tests for screening potential mutagenic agents. (auth)

28427 THE GENOTYPIC CONTROL OF RADIOSENSITIVITY OF ORGANISM. Aleksandrov, S. N. Radiobiol.-Radiother., 8: 501-16(1967). (In German).

In order to determine in which concrete forms and in which ways the genotypic control of radiosensitivity of organism is realized, animals of two mouse lines (A and C 57-black) as well as eight laboratory lines of Drosophila (wild strain) were irradiated. It was found that the different radioresistance of animals of different lines correlates with the different sensitivity of genetic cell-structures to the mutagenic effect of ionizing radiation. In selective experiments with Drosophila it was demonstrated that this correlation is not incidental: selection according to one of these features (mutagenic effect of radiation) appeared effective also in the relation of others (lethal effect of radiation). Interlinear differences in the resistance of mice and Drosophila did not only appear for ionizing radiation but also for some other agents that do not have mutagenic properties. For all examined effects, interlinear differences in the resistance of organism had the same direction thus having an unspecific character. The existing data permit the statement that of the two properties forming the radiosensitivity of biological objects—primary sensitiveness and repairability—the latter one has the leading part in the realization of the genotypic control of sensitivity to the effect of ionizing radiation on the cellular level. The differences in repairability on the cellular level apparently involve a different degree of disturbance of the unspecific antialterative (adaptive) system of organism. This is the direct cause of the difference in the resistance of organism as a whole. (auth)

28428 SCREENING TECHNIQUE FOR THE ISOLATION OF BACTERIAL MUTANTS SENSITIVE TO IONIZING RADIATION. Borsa, J.; Hunt, J. W. (Univ. of Toronto, Ontario Cancer Inst., Toronto). Radiat. Res., 34: 128-37(1968).

A screening technique for the rapid isolation of bacterial mutants sensitive to ionizing radiation utilized the radiosensitivity of the mutants for their detection. Aliquots of the cell suspension were plated on agar plates and incubated at 37°C for approximately ten hours. The plates were irradiated with a dose of gamma radiation sufficient to reduce the survival of the parent population to between 10% and 50% and were incubated for a further 18 to 24 hours. Visual inspection of the plates at this time revealed, among the normal clones, the presence of a small percentage of minute clones. Any clones composed of radiosensitive cells were found among these. A second rapid screening permitted the true radiosensitive mutants to be isolated with ease. The screening procedure was employed to isolate a spontaneously arising radiosensitive mutant from a culture of Escherichia coli K12 AB1157. (A.W.B.)

28429 SAMPLING TIME AND THE COMPLEXITY OF THE HUMAN LEUKOCYTE CULTURE SYSTEM. Heddle, John A.; Evans, H. J.; Scott, David (Medical Research Council, Harwell, Eng.). pp 6-19 of Human Radiation Cytogenetics. Evans, H. J.; Court Brown, W. M.; McLean, A. S. (eds.). New York, John Wiley and Sons, Inc., 1967.

From International Symposium on Human Radiation Cytogenetics, Edinburgh. See CONF-661062.

The effect of different fixation times on the aberration frequencies of x-irradiated phytohemagglutinin-stimulated cultured human leukocytes was investigated. Variations with time appear to be due to the appearance of second and subsequent mitoses. The 72 hr standard fixation time is not only too late to find many first division cells, but is on the borderline between the second and third mitoses where small differences in timing would exaggerate variations in frequencies. For this reason many previous conclusions about the effects of various agents and conditions on aberration frequency must be considered tentative until further investigation. Determination of the pattern of mitotic index change with time may provide a guide to when aberration frequencies can be accurately determined. (M.M.B.)

28430 DOSE-RESPONSE RELATIONS FROM IN VITRO STUDIES. Evans, H. J. (Univ. of Aberdeen, Scotland). pp 20-36 of Human Radiation Cytogenetics. Evans, H. J.; Court Brown, W. M.; McLean, A. S. (eds.). New York, John Wiley and Sons, Inc., 1967.

From International Symposium on Human Radiation Cytogenetics, Edinburgh. See CONF-661062.

The relation between x ray dose and yield of dicentric and ring aberrations was examined in phytohemagglutinin-stimulated human peripheral blood leukocytes irradiated in vitro and cultured for 50 to 54 hr. Aberrations were scored in metaphase cells observed in their first mitosis in culture. A whole-blood microculture system was used. Whether cells were irradiated before or after culture (up to 24 hr) made no difference. The aberration yields at doses below 300 rads were considerably higher than the yields reported in the earlier studies, and the exchange aberrations were found to increase in proportion to the 1.17 ± 0.04 power of the dose and not as the square of the dose. The earlier studies may represent sampling from second and third post-irradiation mitosis. Human peripheral blood leukocyte chromosomes appear to be more radiosensitive than chromosomes of higher plants. (M.M.B.)

28431 RBE FOR FAST NEUTRONS AND DOSE RATE STUDIES USING FAST NEUTRON IRRADIATION. Scott, D. (Medical Research Council, Harwell, Eng.); Batchelor, A. L.; Sharpe, Heather; Evans, H. J. pp 37-52 of Human Radiation Cytogenetics. Evans, H. J.; Court Brown, W. M.; McLean, A. S. (eds.). New York, John Wiley and Sons, Inc., 1967.

From International Symposium on Human Radiation Cytogenetics, Edinburgh. See CONF-661062.

Preliminary data are presented on the relation between chromosome aberration frequency and dose of fast neutrons (mean energy 0.7 MeV) delivered chronically or acutely to phytohemagglutinin (PHA)-stimulated and non-stimulated human lymphocytes in vitro. The RBE for fast neutrons was determined by comparing these results with those of Evans. The average RBE for dicentrics + rings was 3. No difference was found between the sensitivity of lymphocytes irradiated in the stimulated and non-stimulated conditions when 6.75 rad/hr was used, but a difference was found when the rate was 3.41 rad/hr. Aberrations increased linearly with increasing acute neutron doses, but the data from chronic neutron irradiation did not clearly fit a linear model. (M.M.B.)

28432 MULTI-HIT ABERRATIONS. Norman, Amos (Univ. of California, Los Angeles). Contracts AT(11-1)-34; AF41(609)-2944. pp 53-7 of Human Radiation Cytogenetics. Evans, H. J.; Court Brown, W. M.; McLean, A. S. (eds.). New York, John Wiley and Sons, Inc., 1967.

From International Symposium on Human Radiation Cytogenetics, Edinburgh. See CONF-661062.

Data are presented on the production and elimination of chromosome aberrations in cultured lymphocytes from man. It was calculated that an average in vitro dose of 2×10^2 rad would lead

to one event per cell that could result in a terminal deletion or exchange aberration. Each dicentric was accompanied by a single acentric fragment. The number of dicentrics found in normal young adults is extremely small, making this easily scored aberration a useful indicator of radiation damage in man. The frequency of dicentric formation in a given chromosome correlates with its metaphase length. (M.M.B.)

28433 CHROMOSOME ABERRATIONS AND IMMUNOLOGICAL MEMORY. Nowell, Peter C. (Univ. of Pennsylvania, Philadelphia). pp 99-105 of Human Radiation Cytogenetics. Evans, H. J.; Court Brown, W. M.; McLean, A. S. (eds.). New York, John Wiley and Sons, Inc., 1967.

From International Symposium on Human Radiation Cytogenetics, Edinburgh. See CONF-661062.

Unstable chromosome changes observed in leukocyte cultures from irradiated patients, provide a means of identifying long-lived lymphocytes in man. Use was made of this system to test the hypothesis that human peripheral blood contains immunologically committed small lymphocytes that may survive for years without dividing until exposed to the sensitizing antigen. When antigen-stimulated and phytohemagglutinin (PHA)-stimulated cultures from irradiated humans were compared, the results were similar immediately after irradiation, but with time the frequency of cells with unstable chromosome aberrations appeared to decrease more rapidly among antigen-stimulated lymphocytes than among those stimulated by PHA. Because data from irradiated patients was inconclusive, animal experiments were initiated. Efforts are being made to develop a satisfactory culture system for rat lymphocytes. (M.M.B.)

28434 THE ESTIMATION OF LYMPHOCYTE LIFESPAN FROM STUDIES ON MALES TREATED WITH X RAYS FOR ANKYLOSING SPONDYLITIS. Buckton, Karin E.; Smith, P. G.; Court Brown, W. M. (Western General Hospital, Edinburgh). pp 106-14 of Human Radiation Cytogenetics. Evans, H. J.; Court Brown, W. M.; McLean, A. S. (eds.). New York, John Wiley and Sons, Inc., 1967.

From International Symposium on Human Radiation Cytogenetics, Edinburgh. See CONF-661062.

Chromatid aberrations, unstable chromosome abnormalities (such as rings, dicentrics, or acentric fragments), and stable abnormalities were measured in cultured lymphocytes from spondylitis patients at various times (up to ten years) after x-ray therapy. Data were obtained from 129 blood samples from 66 men. The changes with time in the number of lymphocytes with unstable chromosome aberrations led to an estimate of the mean life span of a lymphocyte as 1574 days with 95% confidence limits of 891 and 6743 days. The possibility that these figures may be an overestimation is discussed. (M.M.B.)

28435 CHROMOSOME ABERRATIONS FOLLOWING PARTIAL- AND WHOLE-BODY X IRRADIATION IN MAN. DOSE RESPONSE RELATIONSHIPS. Buckton, Karin E. (Western General Hospital, Edinburgh.); Langlands, A. O.; Smith, P. G.; McLelland, J. pp 122-35 of Human Radiation Cytogenetics. Evans, H. J.; Court Brown, W. M.; McLean, A. S. (eds.). New York, John Wiley and Sons, Inc., 1967.

From International Symposium on Human Radiation Cytogenetics, Edinburgh. See CONF-661062.

Dose response data from patients exposed to therapeutic x irradiation was obtained. Men with ankylosing spondylitis received partial-body irradiations in doses from 100 to 300 rad, one man received 700 rad by accident, and seven men with bronchial carcinoma received whole-body irradiation of 25 and 50 rad. Chromatid aberrations, unstable (dicentrics, rings, and acentric fragments), and stable chromosome aberrations were measured in blood cultures taken before and 24 hr after irradiation. After partial-body irradiation measurements of unstable chromosome aberrations gave a dose response curve that conformed to an equation involving the square of the dose while response to whole-body doses increased more in a linear relation to dose. The damage after a 50 rad whole-body dose was similar to that produced by a partial-body dose of 250 rad. (M.M.B.)

28436 A PILOT STUDY OF THE RELATIONSHIP BETWEEN CHROMOSOME ABERRATIONS AND OCCUPATIONAL EXTERNAL AND INTERNAL RADIATION EXPOSURE. Wald, Niel; Koizumi, Akira; Pan, Sylvia (Univ. of Pittsburgh). pp 183-93 of Human Radiation Cytogenetics. Evans, H. J.; Court Brown, W. M.; McLean, A. S. (eds.). New York, John Wiley and Sons, Inc., 1967.

From International Symposium on Human Radiation Cytogenetics, Edinburgh. See CONF-661062.

Six workers who were employed in nuclear industry for a long time and seven nuclear industry workers who were accidentally exposed to ^{125}I, were measured for whole body radiation and frequency of leukocyte chromosome aberrations. The long term nuclear industry employees had received an average external dose of 40.5 (range from 23.7 to 54.5 rem) at a rate of 4.3 rem/yr. The workers involved in the accident had received an average external dose of 7.5 rem (range from 1.0 to 18.8 rem) at a rate of 1.4 rem/yr. Leukocytes from both the workers (153 cells were scored from the long term workers and 260 from the ^{125}I exposed group) had a higher frequency of chromatid aberrations and unstable chromosome aberrations than 154 cells from a control group of eight persons. A total of six polyploid cells were found in leukocytes from the workers in both groups, while no polyploid cells were found in the control group. Aneuploid cells appeared at the same frequency in all groups with the exception of one long term worker with an unusually high frequency, and stable chromosome aberrations appeared only in the long term worker group. (M.M.B.)

28437 STUDIES OF CHROMOSOME ABERRATIONS IN CULTURES OF PERIPHERAL BLOOD FROM MEN EMPLOYED AT UKAEA ESTABLISHMENTS. Buckton, K. E. (Western General Hospital, Edinburgh); Dolphin, G. W.; McLean, A. S. pp 174-82 of Human Radiation Cytogenetics. Evans, H. J.; Court Brown, W. M.; McLean, A. S. (eds.). New York, John Wiley and Sons, Inc., 1967.

From International Symposium on Human Radiation Cytogenetics, Edinburgh. See CONF-661062.

Chromosome aberrations were measured in 7580 leukocytes from employees of the United Kingdom Atomic Energy Authority (UKAEA) and 1060 from a control group of 38 men. Thirteen UKAEA workers were exposed to doses of less than 1 rad, 19 to an average accumulated dose of 3.8 rad (range of 1 to 10 rad), 14 to 27 rad (23 to 34 rad), seven to 24 (15 to 37), nine to 84 rad (75 to 98 rad), two who were involved in an accident to 17 and 18 rad, one who was involved in the recovery operation got less than 3 rad, one 3 rad, and another 1.9 rad. The doses reported were those recorded by the film badges. The frequency of aneuploidy, chromatid aberrations, or stable chromosome aberrations did not differ significantly between UKAEA employees and controls, but the frequency of unstable chromosome aberrations (dicentrics, rings, and fragments) was higher in those men who had an average accumulated dose of 3.8 rad or more. However, there did not appear to be a dose response relation revealed by these data. (M.M.B.)

28438 RELATIONSHIP BETWEEN EXTERNAL RADIATION EXPOSURE AND CHROMOSOME ABERRATIONS AMONG LUMINOUS DIAL PAINTERS. Boyd, J. T. (University Coll. Hospital, London); Court Brown, W. M.; Woodcock, Gillian E.; Vennart, J. pp 208-14 of Human Radiation Cytogenetics. Evans, H. J.; Court Brown, W. M.; McLean, A. S. (eds.). New York, John Wiley and Sons, Inc., 1967.

From International Symposium on Human Radiation Cytogenetics, Edinburgh. See CONF-661062.

Chromosome studies were conducted on 62 luminous dial painters with estimated burdens ranging from non-measurable amounts of radium to 0.56 μCi, and on 57 control women from the general population. The dial painters had, on the average, worked in the industry for 5 to 7 yr and ended their employment 17 to 19 yr before the chromosome study. The incidence of structurally abnormal cells was higher among the dial painters than among the controls and a gradient of increasing damage with increasing body burden was found. Whether the chromosome aberrations found in cultured leukocytes from these women were induced by external or internal radiation is discussed. (M.M.B.)

28439 CHROMOSOME ABERRATIONS IN OCCUPATIONALLY EXPOSED PERSONNEL, IN A RADIOTHERAPY DEPARTMENT. Visfeldt, Jakob (Univ. of Copenhagen). pp 167-73 of Human Radiation Cytogenetics. Evans, H. J.; Court Brown, W. M.; McLean, A. S. (eds.). New York, John Wiley and Sons, Inc., 1967.

From International Symposium on Human Radiation Cytogenetics, Edinburgh. See CONF-661062.

Chromosome analyses were done on 950 cultured leukocytes from ten healthy individuals exposed occupationally to a constant low level of radiation and on 300 leukocytes from six controls. Irradiated persons had an average of 11.7% aneuploids compared to 9.0% in the unirradiated group. The controls never exhibited dicentrices, tricentrics, or ring chromosomes although they were found in cells from the irradiated group. More acentric fragments appeared in cells from irradiated persons than from controls but no difference was detected in the frequency of deletions between the two groups. (M.M.B.)

28440 CHROMOSOME ABERRATIONS IN PERSONS WITH THORIUM DIOXIDE BURDENS. Fischer, P. (Univ., Vienna); Golob, E.; Kunze-Muehl, E.; Muellner, T. pp 194-202 of Human Radiation Cytogenetics. Evans, H. J.; Court Brown, W. M.; McLean, A. S. (eds.). New York, John Wiley and Sons, Inc., 1967.

From International Symposium on Human Radiation Cytogenetics, Edinburgh. See CONF-661062.

Twenty thorotrast cases selected by the International Atomic Energy Agency were investigated to determine the frequency of chromosome aberrations and to detect any relation between the frequency and the level of radioactivity in the liver and spleen. An additional study was made to determine the reproducibility of data obtained from replicate blood samples from the same person after the same and different periods of culturing. Terminal and interstitial deletions, dicentrics and ring aberrations were recorded. In 19 of the 20 cases aberrant chromosomes were observed with a frequency ranging from 1 to 20%, and the associated frequency of breaks ranged from 3 to 70%. Polyploid cells were present in 15 cases with a frequency of 1 to 6%. A statistical analysis showed a correlation between frequency of breaks and amount of radioactivity. The data from replicate blood samples were variable. It is suggested that caution be exercised in drawing conclusions from a single observation. At least two cultures (at a time when first division mitosis can be scored) should be used and conditions should be standardized. (M.M.B.)

28441 CHROMOSOMAL STUDY OF BONE MARROW AND PERIPHERAL BLOOD IN PERSONS CARRYING BODY BURDENS OF ^{226}Ra AND ^{90}Sr. Tuscany, R.; Muller, J. (Inst. of Radiation Hygiene, Prague). pp 203-7 of Human Radiation Cytogenetics. Evans, H. J.; Court Brown, W. M.; McLean, A. S. (eds.). New York, John Wiley and Sons, Inc., 1967.

From International Symposium on Human Radiation Cytogenetics, Edinburgh. See CONF-661062.

Cultured bone marrow cells and peripheral blood leukocytes from human cases of ^{226}Ra and ^{90}Sr contamination were examined for chromosome aberrations. In bone marrow cells a significant difference was found in the frequency of aneuploidy between exposed persons and controls, but not among different levels of cumulative body burden. In leukocytes, however, the group with the highest cumulative dose had the highest incidence of aneuploidy. The frequency of dicentrics, rings, and unstable and stable chromosome aberrations in the bone marrow and leukocytes was higher in the exposed group than in the control group. (M.M.B.)

28442 COMPARISON OF RADIATION EFFECTS IN VITRO UPON CHROMOSOMES OF HUMAN SUBJECTS. Kucerova, Maria (Inst. of Experimental Biology and Genetics, Prague). Acta F. Vol., Ther. Phys., Biol., 6: 441-8(Dec. 1967).

The culture of lymphocytes from five healthy individuals and five individuals with trisomy of the 21 chromosomes was treated with 300 R from a cobalt-60 source at 18 hours of culture 54 hours before its end. The results of karyological analysis of irradiated cells were compared with those of non-irradiated lymphocytes from the same individuals. A significantly higher incidence of postirradiation chromosome aberrations and a greater decrease in number of modal cells after irradiation was found in trisomic cells. The difference between the type of aberrations, the losses of chromosomes and the number of polyploid cells was not significant. (auth)

28443 MODIFICATION OF GAMMA-RAY MUTAGENIC ACTION BY TEMPERATURE SHOCK. Dishler, V. Ya.; Eizenberg, V. T. Latv. PSR Zinat. Akad. Vestis, No. 1, 78-80(1968). (In Russian).

Air-dried pea seeds of the Torsdag-3 variety were irradiated with γ rays at doses of 20, 30, and 50 kR. For a supplementary treatment, the seeds were irradiated frozen in liquid nitrogen (−170°C), then immersed for 1.5 min in boiled water at a temperature of 60°C and for 1.5 hr in distilled water at 30°C. The supplementary treatment of the seeds decreased the radiation damage at all doses with respect to the criteria of growth and development of the plants and the frequency of induced chromosome breaks. The same frequency and spectra of chlorophyll mutations in the M_2 was larger than in the seeds without supplementary treatment. Supplementary treatment is recommended for increase of the efficiency of the methods of radioselection in plants with albumin type of matter exchange. (tr-auth)

28444 PHYSICAL AND CHEMICAL MUTAGENS IN WHEAT BREEDING. Konzak, C. F.; Nilan, R. A.; Froese-Gertzen, Edith E.; Ramirez, I. A. (Washington State Univ., Pullman). Contract AT(45-1)-353. pp 65-84 of Proc. 2nd Int. Wheat Genetics Symp., Lund 1963, Suppl. Vol. 2, 1966.

Evidence from induced mutation studies shows that significant agronomic improvements can be obtained in wheat. Those improvements, now well substantiated, include increased yield, straw shortening, and increased lodging resistance, in some cases properties of the same mutants. Awned mutants from awnless varieties appear to give increased yields. Quality characteristics of mutants may be the same as the parent variety, less desirable or improved. However, since losses in desirable traits frequently occur in conjunction with gains of desirable traits, many desirable mutants may require modification by hybridization. Where low mutation frequencies, high levels of gross chromosome aberration, and low survival have previously been a serious drawback to the usefulness of such mutagens as radiations, chemical mutagens (especially ethyl methanesulfonate) appear to offer unusual promise as agents for increasing variability in breeding programs. These chemicals are not only cheap, but also easy to apply to seeds. For maximum mutagenic efficiency with chemicals as with radiation, attention must be given to the physical and chemical properties of the mutagen, the nature of the biological material, and the influence of modifying factors. The significant progress achieved in mutation experiments to date has raised new questions. These questions relate no longer to whether mutagens are likely to be useful in plant breeding, but rather to the ways that they can be used most effectively. (auth)

28445 HUMAN RADIATION CYTOGENETICS. Proceedings of an International Symposium held in Edinburgh, 12–15 October 1966. Evans, H. J.; Court Brown, W. M.; McLean, A. S. (eds.). New York, John Wiley and Sons, Inc., 1967. 225p. $11.50. (CONF-661062).

A conference was held on the subject of radioinduced aberrations in human cultured leukocytes. Seven papers were presented on the techniques of in vitro studies and 13 on the lymphocyte and in vivo studies. Separate abstracts have been prepared for 15 of these papers. Those not abstracted contain information on culture techniques, machines for chromosome analysis, the small lymphocyte, and chromosome aberrations in unirradiated populations. (M.M.B.)

For abstracts of individual papers see: 28429–28441, 28574, and 28575.

Health Physics and Safety

Refer also to abstracts 27916, 28157, 28187, 28271, 28307, 28336, 28384, 28435–28437, 28441, 28547, 28551, 28577, 28594, 28662, 28681, 28727, and 30280.

28446 (AERE-R-5688) RADIOACTIVE AEROSOLS IN SOME SELECTED AREAS AT A.E.R.E. PARTICLE SIZE DISTRIBUTIONS AND LONG TERM MEAN CONCENTRATIONS MEASURED BY PERSONAL AND STATIC AIR SAMPLERS. Stevens, D. C. (Atomic Energy Research Establishment, Harwell (England)). Jan. 1968. 18p. Dep. CFSTI. UK 3s. 0d.

Centripeters and personal air samplers were used over a period of one year to measure the particle size of radioactive aerosols in various buildings at A.E.R.E., and to examine the relationship between personal exposure and exposure measured by an environmental (static) sampler. The activity median aerodynamic particle diameter associated with the airborne activity in an incinerator building and filter house was 5 to 6 μm for both alpha and beta activity, with a geometric standard deviation of 2.5 to 3.0. Similar size distributions were obtained for beta activity in a high activity handling building and a wet decontamination area, but airborne alpha activity in the latter showed a median diameter of 3.5 μm with a geometric standard deviation of 4.3. The air concentrations measured by samplers operating on a weekly basis were statistically analysed, and the convenience of the log-normal distribution is demonstrated. It is shown that in areas where the source of airborne contamination is widespread and not directly associated with particular operations, the long term mean exposure indicated by personal samplers is similar (within a factor of 2 or 3) to that indicated by the static (centripeter) sampler. However, in an area, such as a decontamination area, where each man generates a localized aerosol, the mean exposure indicated by personal samplers is often 10 or more times higher than that shown by a static sampler. (auth)

28447 (ANL-7278, pp 304-13) ENVIRONMENTAL RADIATION STUDIES. (Argonne National Lab., Ill.).

CESIUM-137 — content of environment of Chicago during 1966
OSTEICHTHYES — content of cesium-137, manganese-54, polonium-210, and zinc-65 in, in relation to ecosystem
RAINWATER — analysis for bismuth-214, lead-212, and lead-214 during 1966
BERYLLIUM-7 — content of stratosphere during 1963 and 1964
ATMOSPHERE — content of lead-210 and stable lead at Argonne, Illinois; content of nuclear test debris in upper, use of balloon-borne γ-ray spectroscopy to locate; cesium-137 content of, in Illinois during 1964 to 1966 (H.L.W.)

28448 (NYO-2147-13, pp 64-71) ESTIMATION OF BODY COMPOSITION AND ^{137}Cs BODY BURDENS IN COLLEGE WOMEN USING THE WHOLE BODY COUNTING TECHNIQUE. Kallfelz, F. A. (New York State Veterinary Coll., Ithaca. Dept. of Physical Biology).

A cooperative study is underway in which the determination of lean body mass and fat content of college age women is being determined by several different methods including the ^{40}K method using the Cisco counter. The results from whole-body counting will then be compared with the results obtained from skin-fold measurements and densitometric techniques. In addition, an estimation of ^{137}Cs content was made on all subjects counted to date. (auth)

28449 (NYO-2147-13, pp 122-33) URINE/DIET STUDIES AMONG TEENAGERS: CONTINUATION OF ALTERNATIVE METHODS DEVELOPMENT FOR ESTIMATING DIETARY ^{90}Sr. Thompson, J. C. Jr. (New York State Veterinary Coll., Ithaca. Dept. of Physical Biology).

Studies conducted with two groups of teenagers (13 and 16 years) further quantify the age dependent relationship of the $OR_{urine/diet}$ which was observed in earlier studies among adults and preschool children. Incorporation of the teenage data into prediction equations gives a more reliable base for the use of urinary samples to estimate dietary ^{90}Sr. (auth)

28450 (NYO-2147-13, pp 134-40) POOLED URINE SAMPLES FOR ESTIMATING RADIONUCLIDE LEVELS. Thompson, J. C. Jr. (New York State Veterinary Coll., Ithaca. Dept. of Physical Biology).

Sampling procedures and collection patterns were developed for urinary sampling of defined populations. Analytical problems prevented accurate estimation of dietary ^{90}Sr levels from urinary samples. Poor ^{90}Sr and calcium determinations by commercial laboratories as well as losses incurred in sample shipments delayed the verification of this method of estimation. Further attempts at resolving these problems include laboratory intercomparisons and repeat of the experiment in which samples were lost in transit. ^{137}Cs determinations on urinary samples from this project were used to estimate body burdens with good accuracy. (auth)

28451 (NYO-2147-13, pp 141-51) NON-MILK CONTRIBUTION OF ^{131}I TO DIET: COMPARISON BETWEEN MILK AND NON-MILK FOODS. Thompson, J. C. Jr. (New York State Veterinary Coll., Ithaca. Dept. of Physical Biology).

Non-milk ^{131}I could make a significant contribution to total ^{131}I intake among certain population groups. Estimations were made for some of these groups during the June–September 1962 period. The possibility of a 20 to 40 per cent non-milk ^{131}I contribution was indicated for farm families, rural families with gardens, and other non-urban population categories. Since there are nearly 50 million persons in the United States included in these groupings, the nature and magnitude of this contribution should be more carefully examined. Appropriate remedial measures may simply require converting to processed foods when the occasion demands action, but no procedures or plans have been established to meet this need. (auth)

28452 (NYO-2147-13, pp 152-9) NON-MILK CONTRIBUTION OF ^{131}I TO DIET: EXPERIMENTAL ^{131}I STUDIES IN PASTURE AND FOOD PLANTS. Thompson, J. C. Jr. (New York State Veterinary Coll., Ithaca. Dept. of Physical Biology).

Green beans and pasture were grown in adjacent plots and contaminated with ^{131}I solutions. A bean/pasture ratio of 0.03 to 0.05 was indicated. Removal rates for washing were calculated and averaged 40 to 50 per cent for field application studies. Laboratory studies indicate a similarity to field studies if similar air, light, and temperature conditions are present. Increasing ^{131}I concentration levels from 1 to 5 μCi ^{131}I/liter did not influence removal rates under rinsing experiments. (auth)

28453 (NYO-2147-13, pp 160-7) PRACTICALITY OF DECONTAMINATION PROCESSES AS RELATED TO FOOD TECHNOLOGY. Thompson, J. C. Jr. (New York State Veterinary Coll., Ithaca. Dept. of Physical Biology).

Milk ^{90}Sr levels were used to estimate ^{90}Sr levels for the four major dietary sub-groups (Dairy, Grain, Fruits and Vegetables, and Animal Protein Foods) in various countries of the world. These data were then modified on the basis of expected effects from standard food preparation and processing practices to determine the amount of ^{90}Sr normally removed prior to consumption. Reductions in total dietary ^{90}Sr intake were estimated to fall in the 10 to 30 per cent range. Direct correspondence between the degree of marketing services performed and the level of ^{90}Sr removal were noted. Thus, the more developed countries could expect greater reductions and still retain the economic capability for achieving further reductions. Nearly 80 per cent of the dietary ^{90}Sr intake could be eliminated in developed countries if maximal countermeasures were employed. Since the less developed countries cannot achieve this reduction without outside aid, it is necessary to examine these differences and consider appropriate emergency policies for improvement of these capabilities. (auth)

28454 (NYO-2147-13, pp 168-74) RADIONUCLIDE PLANT AND SOIL RELATIONSHIPS UNDER NORMAL CULTIVATION PRACTICES. Thompson, J. C. Jr. (New York State Veterinary Coll., Ithaca. Dept. of Physical Biology).

Soil and vegetable ^{90}Sr and ^{137}Cs levels show the effects of changes in fallout deposition rate during 1965 and 1966. ^{90}Sr levels for cultivated sites continue to be significantly less than from uncultivated sites. (auth)

28455 (NYO-2147-13, pp 175-9) CLIMATOLOGICAL ASPECTS OF ^{90}Sr LEVELS IN MILK. Thompson, J. C. Jr.; Westman, R. S.; Hiltz, F. L. (New York State Veterinary Coll., Ithaca. Dept. of Physical Biology).

Development of a model to study the influence of climatological factors, radionuclide content of the atmosphere and time on the radionuclide content of milk has been continued into the stage of computer planning and programming. Because of the complexity of the program and the extensive computer analysis needed to complete this study it has been proposed as a separate project. A description of the scope and budgetary needs are included as Phase IV of the contract proposal. (auth)

28456 (ORNL-P-3048) DISTRIBUTION OF DOSE AND DOSE EQUIVALENT IN AN ANTHROPOMORPHIC PHANTOM RESULTING FROM BROAD-BEAM SOURCES OF MONOENERGETIC NEUTRONS. Snyder, W. S.; Auxier, J. A.; Brown, M. D.; Jones, T. D.; Boughner, R. T. (Oak Ridge National Lab., Tenn.). [1966]. Contract W-7405-eng-26. 28p. (CONF-661001-51). Dep. CFSTI.

From 14th Conference on Remote Systems and Technology, Pittsburgh, Pa.

A Monte-Carlo-type program was coded for a digital computer to estimate dose in a tissue phantom from a variety of neutron sources with neutron energy not exceeding 14 MeV. The program allowed for elastic and inelastic scattering as well as for 14 absorption interactions. The cross-section data were taken from BNL-325 or other literature as available, and remaining gaps in the cross-section data were filled by linear interpolation. In some cases, information on the energies of secondary particles produced by an absorption interaction was not found in the literature and was calculated so that both momentum and energy were conserved in the interaction. The phantom consisted of a right circular cylinder with a radius of 15 cm and a height of 60 cm and was thus a reasonable approximation of a human torso. It was considered to be homogeneous and composed of H, C, N, and O in the proportions indicated for standard man. With some rewriting of the source subroutine, the program could be used for a wide variety of sources, but only results for a monodirectional, monoenergetic, broad, lateral beam of neutrons are reported here. Results were obtained for a selection of energies ranging from thermal to 14 MeV. Over the range below 10 MeV, the maximum doses did not differ greatly from the maximum doses in slabs as given in NBS Handbook 63. However, a greater difference was found when the results for slabs and cylinders were compared at depths well below the irradiated surface. (auth)

28457 DISPOSAL OF RADIOACTIVE WASTES FROM U.S. NAVAL NUCLEAR-POWERED SHIPS AND THEIR SUPPORT FACILITIES. Vaughan, J. W.; Miles, M. E. (Bureau of Ships, Washington, D. C.). Radiol. Health Data Rep., 7: 257-62(May 1966).

Data are presented on disposal of radioactive wastes from U. S. Naval nuclear-powered ships and their support facilities and summarizes results of environmental monitoring performed to confirm adequacy of waste disposal limits and procedures. The waste disposal data presented show that the total long-lived radioactivity in liquid waste discharges associated with operation and maintenance of Naval nuclear-powered ships was less than two curies per year in any harbor. Results of environmental surveys of harbor water and bottom sediment for gross radioactivity and for ^{60}Co have shown that no increase in radioactivity above normal background levels was detected in harbor water, discharges of liquid wastes from U. S. naval nuclear-powered ships have not caused a measurable increase in the general external background radioactivity of the environment, and low-level ^{60}Co radioactivity was detected in localized areas of harbor bottom sediment around a few piers at operating bases and shipyards, where maintenance and overhaul of Naval nuclear-powered ships were conducted over a period of several years. This report confirms that procedures issued by the Navy to control discharges of radioactivity from U. S. Naval nuclear-powered ships and their support facilities are effective in protecting the health and safety of the general public. These Navy procedures, that were reviewed and concurred in by the U. S. Public Health Service and the U. S. Atomic Energy Commission, contain discharge limits that are consistent with applicable recommendations of the Federal Radiation Council, U. S. Atomic Energy Commission, and the International Commission on Radiological Protection. (auth)

28458 DATA. Radiol. Health Data Rep., 7: 269-316(May 1966).

Data are presented on the routine monitoring of the ^{89}Sr, ^{90}Sr, ^{131}I, ^{137}Cs, and ^{140}Ba content of milk by the Pasteurized Milk Network, Canadian Milk Network, and Pan American Milk Sampling Program for Jan., 1966. State milk surveillance activities are given for Connecticut, Indiana, Michigan, Minnesota, New York, and Pennsylvania indicating the radioisotope content of milk during the last half of 1965. Radioisotope content of Institutional Diet Samples is given for July to Sept., 1965 in the United States, and the gross radioactivity content of surface waters in the United States during Nov., 1965 is reported. A report is also given of the gross β- and γ-radioactivity content of surface waters in Washington during June, 1964 to June, 1965. Radioactivity content of airborne particulates and precipitation is reported for North America during Jan., 1966. The environmental levels of radioactivity at selected Atomic Energy Installations for Jan. to June, 1965 are reported; these include Lawrence Radiation Laboratory and Mound Laboratory. The Atomic Energy Commission announced five underground nuclear tests at the Nevada Test Site during April, 1966 and reported seismic readings from the Soviet test site at Semipalatinsky. (E.L.B.)

28459 THE GALVESTON ENVIRONMENTAL SURVEILLANCE PROGRAM, 1965. Flora, David H.; Wukasch, Martin C. (Texas State Dept. of Health, Austin). Radiol. Health Data Rep., 7: 263-7(May 1966).

Environmental surveillance between March 10 and August 20, 1965, at the Galveston refueling and servicing site for the Nuclear Ship Savannah indicated no detectable radioactive contamination attributable to the ship's operations. Surveillance activities that have continued at this site since 1962, include air, rain, sea water, silt, shellfish (oysters), and milk sampling. During the Savannah's 1965 visit, almost all analytical results for environmental samples were close to or below detectable limits, except for milk. Radioactivity trends in milk samples at this time closely followed the nationwide trend reported by the U. S. Public Health Service. (auth)

28460 THE CONCENTRATIONS OF ^{137}Cs AND ^{90}Sr IN THE FLESH OF BROWN TROUT TAKEN FROM RIVERS AND LAKES IN THE BRITISH ISLES BETWEEN 1961 AND 1966: THE VARIABLES DETERMINING THE CONCENTRATIONS AND THEIR USE IN RADIOLOGICAL ASSESSMENTS. Preston, A.; Jefferies, D. F.; Dutton, J. W. R. (Ministry of Agriculture, Fisheries, and Food, Lowestoft, Eng.). Water Res., 1: 475-96(July 1967).

Concentrations of ^{137}Cs and ^{90}Sr in the flesh of brown trout were reported for a six yr. period of Lake Trawsfynydd (Merioneth, North Wales), with a comparison of radioactive fallout deposited and water and flesh concentrations for both radioisotopes, along with a general survey of waters throughout the British Isles. From the British Isles surveys, ^{137}Cs concentrations were related to K concentrations in the water and ^{90}Sr concentrations to Ca concentrations in the water, both as activities and as concentration factors, for the whole range of conditions from very dilute calcium bicarbonate surface waters to the marine conditions of coastal waters. Concentrations of ^{137}Cs in brown trout flesh from some Scottish waters were found to be as high as any recorded from arctic ecosystems. Concentrations of both contaminants in trout flesh could be expressed as functions of water conductivity in calcium bicarbonate surface waters from Britain, and it was suggested that this was a useful general approach to radiological assessments involving fish from many such surface waters. The radiological implications of the principal conclusions were discussed and simple "risk diagrams" were produced as a guide to the assessment of different situations. It was shown that ^{90}Sr, at or below I.C.R.P. public drinking water concentrations, was unlikely to be a hazard as a result of the human consumption of trout from any area in the British Isles, but that ^{137}Cs was a potential hazard in some areas down to consumption rates as low as 0.4 g of flesh per day. Previous results with these two radioisotopes in fresh-water ecosystems were discussed in the context of the present studies. (BBB)

28461 EXPERIENCES WITH IMPROVED METHODS OF RADIATION PROTECTION IN RADIUM TREATMENT OF GYNECOLOGIC DISEASES AT A SMALL RADIOTHERAPY DEPARTMENT. Pauwen, J. (St. Clemens-Hospital, Geldern, Ger.). Geburtsh. Frauenheilk., 25: 655-9(July 1965). (In German).

The physical arrangement and operational procedures that permit as many as 200 to 250 Ra insertions to be performed annually, using a single Ra treatment room and a team of four were described. The total average annual irradiation exposure of each person amounted to much less than the permissible annual dose of 5 R, and did not exceed much more than 3 R annually. The floor plan of the Ra treatment room was shown, and the separate functions of each person were detailed. The time required for each Ra insertion was slightly less than two min. Film badges were worn to monitor the irradiation received by each person who participated in the treatment procedures. In larger installations, where more than 200 Ra insertions are performed a second treatment room adjacent to the first one is required. In this case the facilities for the storage of Ra and the loading of the applicators should be provided for in a partition between these rooms, where it will be accessible from both rooms. (BBB)

28462 GENETIC HAZARD FROM DENTAL RADIOLOGY. Smith, N. J. D. (King's Coll., London). Dent. Pract. Dent. Rec., 17: 424-8(Aug. 1967).

The extent of the hazard which arises from dental radiology was examined on the basis of the gonad dose arising from various radiographic techniques, the cumulative dose to the gonads of that section of the population which is potentially capable of reproduction (the genetic dose), and the assessment of the damage to the hereditary factors of the population at large. Some previously published figures for the gonad dose resulting from intra-oral radiography were tabulated. At the low doses encountered in dental radiology, the risk to an individual patient of the induction of genetic changes so that he produced a child with visible genetic damage was extremely small. It was estimated that the annual genetically significant radiation dose from dental x ray diagnosis in Japan in 1958 was 0.0012 mrem. The report of the Adrian Committee, Radiological Hazards to Patients (1960), estimated a value of 0.01 mR per person per year for the United Kingdom. It was argued that a dose of this size might result in from one to ten genetically disabled persons being born each generation in the United Kingdom. (TSS) (BBB)

28463 NATURAL RADIOACTIVITY IN SEAWEEDS AND SEA WATER CONCENTRATES OF SAURASHTRA COAST. Suru, D. P.; Talreja, S. T.; Vaidya, V. H. Salt Res. Ind. (Bhavnagar, India), 3: 128-30(1966).

Data on the natural radioactivity associated with various brown, green and red seaweeds and the sea water concentrates are presented. Gracilaria milardetii, Ulva f., Sargassum Sw. and Cladphora sp. show appreciable beta activities in that order. With 34.5°Be. bittern, the max. activity recorded is 1 to 2 $\mu\mu$Ci/10 ml. (Indian Sci. Abstr.)

28464 THE CARCINOGENIC HAZARDS OF IONIZING RADIATION IN DIAGNOSTIC AND THERAPEUTIC RADIOLOGY. Stein, Justin J. (Univ. of California, Los Angeles). CA - Cancer J. Clin., 17: 278-87(Nov.-Dec. 1967).

Sources of radiation exposure of the population, radiation effects, and hazards of medical irradiation were reviewed. It was estimated that 120 mrad is the average annual gonadal dose which results from the radioactivity in the soil, food and body substances, and from building materials, the amount depending upon such factors as geographic location and the type of building materials used. Such natural irradiation accounts for almost 58% of the radiation exposure. About 41% of the exposure resulted from man-made sources such as medical and dental x ray examinations, nuclear medicine examinations and industrial employment in occupations utilizing radiation. The effects of radiation, divided into acute or chronic forms, were discussed, including the production of cataracts, anemia, shortening of life, skin and kidney injury, and the development of malignant tumors including leukemia. It was emphasized that no individual should be denied any diagnostic procedures involving radiation solely on the basis of potential genetic harm. The beneficial results of any examination indicated, based on clinical judgment, far outweighed any possible harmful effects. Every possible effort should be made to improve radiation equipment, techniques, and the education of physicians and technicians using such equipment to further reduce the amount of radiation exposure to the population. In diagnostic and therapeutic radiology, when the radiation is used under proper conditions, the potential hazards are exceedingly small. (BBB)

28465 ROLE OF PARTICLE SIZE IN THE DISSOLUTION OF LUNG BURDENS. Mercer, T. T. (Univ. of Rochester, N. Y.). Health Phys., 13: 1211-21(Nov. 1967).

Calculations of the rate at which mass dissolves from a population of particles, having initially a log-normal size distribution and introduced simultaneously into a liquid medium, show that the amount remaining undissolved at time t is a function only of σ_g, the geometric standard deviation of the initial distribution, and a dimensionless parameter, $\beta \propto kt/D_m$, where k is the solubility rate constant of the particulate material and D_m is the mass median diameter of the initial distribution. For $1.65 < \sigma_g < 2.72$,

the undissolved mass can be expressed as the sum of two exponential terms in β, a relationship which permits extending the calculations to the situation in which the dissolving mass is continually augmented with particles of the same size distribution. The results are interpreted in terms of lung clearance and compared with experimental data. (auth) (UK)

28466 DOSIMETRY AND THE TECHNICS OF HIGH-ENERGY RADIOTHERAPY. TECHNICAL PART. Chvojka, Zdenek (Charles Univ., Hradec Kralove, Czech.). Sb. Ved. Pr. Lek. Fak. Karlovy Univ. Hradci Kralove, 9: Suppl. 5, 525-44(1966). (In Czech).

Dose distribution and measurement with ^{60}Co γ and high-energy x radiation are discussed. Stationary field treatment of tumors by such radiations did not require radical changes in the methods in comparison to conventional stationary deep x-ray therapy. However, it offered several advantages (easier choice of portals and fewer fields during cross-fire radiation) as well as several disadvantages (necessity to choose fields such that the total integral dose was increased), which could cause various problems. Isodose charts were shown for ^{60}Co γ rays and 15-MeV x radiation for various body zones, and the corresponding incident and integral doses to be used for tumors in these zones were stated. For use with stationary telecobalt therapy, radiation charts for treatment of tumors of the thorax, abdominal cavity, and pelvis, and methods of irradiation of tumors of other locations were shown. (BBB)

28467 RADIOACTIVITY IN THE INDIVIDUAL: CONTAMINATION OF SOFT TISSUES OF INFANTS AND CHILDREN WITH RADIOACTIVE FALLOUT AS EXEMPLIFIED BY ^{137}Cs AND ^{131}I. Hanson, Wayne C. (Pacific Northwest Lab., Richland, Wash.). Pediatrics, 41: Suppl., 240-56(Jan. 1968).

Maximum exposures to ^{131}I within the continental United States have generally occurred among Utah children. From 1952 to 1962, ~40,000 to 50,000 children in Utah were estimated to have received doses to the thyroid glands of a few rad from ^{131}I on several occasions; and, during 1953 about 700 infants at St. George, Utah, received an estimated dose of 84 rad. This was about five times the maximum dose received by English children immediately following the Windscale accident and about $^1/_{10}$ the ^{131}I dose estimated to have resulted in thyroid nodules in a few Marshallese children several years after exposure. Cesium-137 is most important in arctic regions, where whole-body burdens are several orders of magnitude greater than those of temperate North America and Europe. Ecologic factors facilitate the effective transfer of ^{137}Cs through the lichen-caribou-man food chain. The distribution of ^{137}Cs body burdens within Alaskan native populations showed important influences of ethnic background and cultural practices of the people. Maximum values were consistently found in those persons who consumed caribou. Adults had the greatest whole-body burdens and concentrations, minors contained median amounts, and children (less than 15 yr old) contained the least. There was no difference between the sexes until about the age of 20, males then consistently had more ^{137}Cs than females. Whole-body radiation dose to the Anaktuvuk Pass people from ^{137}Cs body burdens during 1964, the period of maximum values, as about 30% of the amount suggested as a radiation protection guide for that population group. (BBB)

28468 INFLUENCE OF THE RADIOACTIVE FALLOUT ON THE ^{90}Sr LEVEL IN WHEAT IN 1963 TO 1965. Carach, Jozef; Caupka, Stefan. Biologia (Bratislava), 22: 422-30(1967). (In Czech).

A direct relationship between the amount of ^{90}Sr in the fallout which occurred during the vegetation period of wheat and its content in the wheat was observed. The content of ^{90}Sr as determined at Jaslovske Bohunice was 51% higher in 1964, and 67% higher in 1965 than in Bratislavan wheat. Theoretical calculations made on the basis of the fallout agreed well with experimental results. (2 Figures, 3 Tables, 19 Western, 1 USSR reference.) (JPRS)

28469 SWEDISH NATIONAL SURVEY FOR ^{137}Cs IN MEAT. Aberg, Bertil (Royal Veterinary College, Stockholm). Pol. Arch. Wet., 9: 421-33(1965).

An account is given of the principles of Swedish meat control as to content of radiocesium ^{137}Cs. The special problems caused by the high intake of reindeer meat by Laponians are pointed out. There is within districts where the calcium content is equal a fairly constant relationship between ^{137}Cs in meat and in milk as well as between ^{90}Sr and ^{137}Cs concentrations in milk. (auth)

28470 RADIATION-HYGIENIC MEASURES DURING LIQUIDATION OF AN AIRCRAFT CRASH CONNECTED WITH RADIOACTIVE CONTAMINATION. Csupka, Stefan (Krajska Station of Hygiene, Bratislava); Carach, Jozef; Petrasova, Maria; Trnovec, Tomas; Minarik, Frantisek; Schulz, F.; Nosal, M. Prac. Lek., 19: 445-9(Dec. 1967). (In Czech).

The article discusses the crash of an aircraft near Bratislava. All 82 people on board were killed, and containers with ^{131}I were damaged during the crash. The amount of the radioactive material was 2,250 Ci of total activity. External radiation in the contaminated area varied between 50 μR/hr and 200 μR/hr. On the bodies of the killed passengers the radiation varied between 0.15 and 1 μCi. On four of the bodies where the radiation exceeded 1 μCi, decontamination was effected by washing with water. 4 Figures, 1 Table, 2 Western refs. (JPRS)

28471 NEW TRENDS IN THE INTERNATIONAL RECOMMENDATIONS IN THE ESTABLISHING OF MAXIMAL DOSES OF IONIZING RADIATION. Musialowicz, T. Pol. Przegl. Radiol. Med. Nukl., 31: 903-10(Nov.-Dec. 1967). (In Polish).

New recommendations of the International Commission on Radiological Protection were published in 1966. Two basic categories were established: exposure of individuals and exposure of populations. The first category was divided into two subdivisions: occupational exposure and exposure of the general public. Recommendations included maximum permissible doses for occupational exposure of individuals, dose limit values for members of the general public, and genetic dose limits for populations. (H.L.W.)

28472 ^{233}Pa "Pu SIMULATOR" FOR THE DIRECT MEASUREMENT OF A PULMONARY CONTAMINATION. Boulay, Pierre; Chivot, Jean-Jacques; Jeanmaire, Lucien; Lansiart, Alain (CEA, Fontenay-aux-Roses, France). Compt. Rend., Ser., D, 265: 1571-4(Nov. 13, 1967). (In French).

The properties of ^{233}Pa that make it a good simulator for ^{239}Pu are pointed out. The x-ray spectrum is similar to that of ^{239}Pu, and the γ rays can easily penetrate several cm of tissue. The half-life is short enough to permit the subject to inhale a sufficient quantity and long enough to allow repetition of the measurements. The procedure for determining pulmonary contamination by this method is outlined. Inhalation of ^{233}Pa by subjects not contaminated with plutonium makes it possible to calibrate the units, to define the geometrical parameters, and to determine effects of individual morphological variations on dispersion of results. (H.L.W.)

28473 PILOT PLANT FIXED-BED ION-EXCHANGE RESIN SYSTEM FOR REMOVING ^{131}I AND RADIOSTRONTIUM FROM MILK. Walter, H. E.; Sadler, A. M.; Easterly, D. G.; Edmondson, L. F. (Dept. of Agriculture, Washington, D. C.). J. Dairy Sci., 50: 1221-5(Aug. 1967).

Results are reported of studies made using an integrated pilot plant system to remove both ^{131}I and ^{90}Sr from milk. The milk was passed through a column containing an anion resin to remove ^{131}I, then through a cation exchange column to remove ^{90}Sr after acidification to pH 5.3. This fixed-bed pilot plant ion-exchange system was tested for removal of the radionuclides, and for the effect on flavor and composition of whole milk. With the Dowex 2 × 8 anion column, more than 93% of ^{131}I was removed from milk in vivo labeled with the isotope. About 90% of environmental levels of ^{90}Sr was removed. Although the resin-treated milks were rated slightly lower than control samples by a trained taste panel, they were considered acceptable and satisfactory as beverage milk. Composition analysis showed that some of the milk fat was adsorbed by the anion resin near the end of an 8-hr run; loss of non-fat solids was much less. (BBB)

28474 INFLUENCE OF COLLIMATING SYSTEMS ON DOSE DISTRIBUTION FROM 10 TO 35 MeV ELECTRON RADIATION. Svensson, H.; Hettinger, G. (Univ. of Umea, Sweden). Acta Radiol., Ther., Phys., Biol., 6: 404-9(Oct, 1967).

The influence of the collimating system on the dose distribution from 10 to 35 MeV electron radiation was studied. A brass collimator placed on the skin gave better isodose curves and less contribution from low-energy scattered electrons, e.g., a better skin-sparing effect in comparison with the original perspex tube. The modified collimator increased the output of the betatron. (auth)

28475 THE BIOLOGICAL HALF-LIFE OF ^{137}Cs IN CHILDREN DETERMINED BY URINARY ASSAY. Cahill, Daniel F.; Wheeler, Jamie K. (Public Health Service, Montgomery, Ala.). Health Phys., 14: 293-7(Apr. 1968).

Urine specimens (24 hr samples) were obtained monthly from 9 to 14-year-old children at six institutions throughout the United States and periodically from a control group at Montgomery during 1966. The samples were analyzed for ^{137}Cs, K and creatinine. The ranges and average levels of these constituents in control urines are presented and discussed. The biological half-life of ^{137}Cs in children was determined to be 53 ± 12 days by means of urinary assay and whole-body counting of the control group. This half-life value and the average urine ^{137}Cs levels at the six institutions were then used to estimate the average ^{137}Cs body burdens at these insti-

tutions. Calculated estimates of average body burdens agreed well with whole-body measurements at two of the institutions. (auth) (UK)

28476 THE WHOLE- AND PARTIAL-BODY DOSIMETRY OF THE RAT EXPOSED TO 250 kVp X-IRRADIATION. Thomas, Walter V.; Maillie, H. David; Mermagen, Herbert (Univ. of Rochester, N. Y.). Contract W-7401-eng-49. Health Phys., 14: 365-71(Apr. 1968). (UR-49-783).

Thermoluminescent microdosimeters containing lithium fluoride and calcium fluoride were used to investigate the effective energy and dose distribution in four rat cadavers exposed to 250 kVp x irradiation. The effective energy and dose distributions were compared with published data where possible. (auth) (UK)

28477 ORGANIZATION OF SPECIAL DECONTAMINATION UNITS IN HOSPITALS. Biese, Arno (Innenministerium des Landes Nordrhein-Westfalen, Dusseldorf). SRW (Siemens-Reiniger-Werke) Nachr., 21: 11-13(Dec. 1963). (In German).

The planning and operational functions of five centers established in North Rhein-Westphalia for treatment of irradiated persons was described. The treatment units were designed so that they could function as a division within the routine operation of the hospital for diagnosis and therapy. They included provisions for monitoring, decontamination, surgical treatment of contaminated wounds, clinical and hematological laboratories, and a special section with eight or ten beds in single, shielded rooms. Unless required for persons who received radiological injuries, these beds were occupied by patients who received therapeutic doses of radioisotopes. Incoming patients were received in a measurement area where they were monitored for gross radiological contamination. If contaminated, their clothing was removed for cleaning. The skin was closely monitored for contamination or evidence of incorporation in order to ascertain the characteristics of the radioactive materials present. Skin contamination was removed by showering or washing with soap and detergents. If internal contamination remained, the patients were assigned to beds in the special section, where they were studied further to remove the radioisotopic contamination. Appropriate precautions to protect the medical personnel against radiological contamination and exposure were taken. Floor plans of the decontamination units were shown. (BBB)

28478 THE GROWING NEED FOR STANDARD METHODS IN ENVIRONMENTAL HEALTH PROGRAMS. Lewis, Keith H. (National Center for Urban and Industrial Health, Cincinnati); Foter, Milton J. Health Lab. Sci., 3: 133-42(July 1966).

The role of the Public Health Service (PHS) in the prevention and abatement of radiologic and other environmental hazards, and the need for valid methods and safe limits were reviewed. The Division of Radiological Health has five regional laboratories in which environmental samples were examined for radioactive levels and selected radionuclides. Consequently, uniform or comparable laboratory methods were necessary in making these determinations. The Division had an Interlaboratory Technical Advisory Committee (ITAC) to promote the uniformity of effort and coordination of activities among the laboratories. Some of the analytical problems considered by ITAC resulted in the establishment of a Quality Control Unit to design and direct collaborative studies of laboratory procedures among Federal, State and municipal laboratories. A committee had established standard criteria and guidelines for selected radionuclides in water. Limits were based on the recommendation of the Federal Radiation Council and published in the PHS Drinking Water Standards. In the discharge of radioactive wastes by industry, the criteria or guidelines were established by the Atomic Energy Commission in their licensing program. Thus where several agencies established guidelines or criteria, there was need for standard methods. Guidelines or criteria had also been established for radionuclides discharged into the air. Several methods for the measurement of selected radionuclides in air were reported but there was a need for the development of sampling procedures and standard laboratory procedures. Although numerous methods had been published in the technical literature for the determination of radioactivity in water, waste water, foods, and air, uniformity among State Health Laboratories and among PHS Divisions remained to be attained. (BBB)

28479 MEDICAL SUPPORT OF NUCLEAR WEAPON ACCIDENTS. Linnemann, Roger E.; Wangemann, Robert T. (Army Nuclear Medical Research Detachment, APO, N. Y.). Med. Bull. U. S. Army Eur., 24: 371-5(Oct. 1967).

The hazards of nuclear accidents, support and control of accident sites, and medical responsibilities in accident/incident control plans are discussed. Statistically, and by actual experience, the most common hazard associated with a nuclear weapon accident was the high explosive (HE) component, which was sensitive to rough handling and temperature. Hazards from fissionable material were also discussed, especially as regards ingestion of Pu and U and methods of enhancing their elimination from the body. Treatment, aimed at removing the Pu in the blood and accelerating its elimination in the kidneys, was based on the use of chelating agents. The two most common agents used were EDTA (ethylenediamine tetraacetic acid) and DTPA (diethylenetriaminepentaacetic acid). The latter was more efficient. Uranium was a hazard only when inhaled or ingested. Less than 0.05% was absorbed from the gastrointestinal tract. The primary means of entrance into the body was via the respiratory tract. Unlike Pu, it was not easily pulverized or readily oxidized, resulting in somewhat less of an inhalation hazard. In spite of its radioactivity, U was primarily a chemical toxic agent. Chemical toxicity from an acute situation such as a nuclear weapon accident was virtually impossible. Proper attention to the Pu hazard automatically precluded a U hazard. Also discussed was the third radiation hazard associated with nuclear weapons, exposure to tritium. Treatment was based on replacing the ^{3}H-labeled water in the body. Fluid, forced to a maximum of five quarts per day, could reduce the 50% water turnover rate to three days. The responsibility for an accident lies with the service or government agency possessing the weapon at the time of the accident. The various teams that were available to support USAREUR nuclear accident plans were described. The monitoring or radiation control teams were responsible for determining the radiation hazard, the extent of the contaminated area, and for supervising the contamination and cleanup procedures. The EOD (Explosive Ordnance Disposal) Team was responsible for disarming and collecting the remains of the weapon. The legal advisor consulted with the control officer on legal implications and public information releases. The security teams established necessary area security. Operations at a nuclear weapon accident site would occur in three phases. In the emergency phase, casualties would be rescued, the weapon disarmed, and the area secured. In the control phase, the area of contamination would be delineated. The third phase would consist of cleanup operations and final disposition of the area. The USAREUR medical service responsibility at a nuclear weapon accident (treatment of casualties and radiation guidance) was described. The Technical Medical Team was provided on a 24-hr alert basis by the USA Nuclear Medical Research Detachment, Europe (NMRDE Landstuhl, APO 09180). (BBB)

28480 ABOUT THE DOSIMETRY OF 17-MeV BETATRON. Fuerst, G.; Hegewald, H.; Wulff, W. (Univ., Berlin). Radiobiol.-Radiother., 8: 455-62(1967). (In German).

The measuring methods used at the institute for the dosimetry of high-energy electrons and ultrahard bremsstrahlung are discussed in principle, all methods are related to the comparison with ionization chamber measurements that were calibrated for the energy range of cobalt gamma-radiation. Therefore, the measured values of a measuring assembly in the ultrahard energy range being obtained under different conditions are compared with each other. The inability to identify the measured value for different geometric dimensions of the standard detectors (for instance film-ionization chamber) is an important source of errors for measurements in electron fields. (auth)

28481 RESPIRATORY PROTECTION PROGRAM AT A NUCLEAR RESEARCH FACILITY. Lipera, Joe; Kusian, Ross N. (Univ. of California, Livermore). Amer. Ind. Hyg. Ass. J., 29: 140-5(Mar.-Apr. 1968).

The Lawrence Radiation Laboratory's respiratory protection program, which is maintained to provide employees with proper, well-fitted equipment, to service equipment that has been used, to train employees in the proper selection and use of this equipment, and to evaluate and develop new products, is described. (auth)

28482 $^{134}Cs/^{137}Cs$ ACTIVITY RATIO IN THE BIOSPHERE FROM 1956 UNTIL 1966. Persson, R. B. R. (Univ. of Lund, Sweden). Health Phys., 14: 241-50(Mar. 1968).

^{134}Cs and ^{137}Cs activities were measured in samples of lichen, moss, and reindeer meat collected in Sweden. The $^{134}Cs/^{137}Cs$ activity ratios in vegetation coincided within the experimental uncertainty with those for reindeer meat, the values being: 1958 (4%), 1959 (3%), 1960 (2%), 1961 (1.5%), 1962 (1.0%), 1963 (0.5%), 1964 (0.25%), 1965 (0.15%), and 1966 (0.11%). γ ray spectra from the annually performed whole-body measurements on Lapps were also analyzed, and the $^{134}Cs/^{137}Cs$ ratios found were: 1962 (1.3%), 1963 (0.9%), 1964 (0.5%), and 1965 (0.3%). The total global injection of ^{134}Cs was estimated to be about 200 kCi up to 1958, insignificant during 1959-1961, and about 50 kCi during 1961-1962. Since 1962 no significant injection of ^{134}Cs has been detected. Different ways of generating ^{134}Cs are considered. (auth) (UK)

28483 WHOLE-BODY COUNTING OF PERSONS CONTAINING ^{90}Sr AND ^{226}Ra: AN INTERLABORATORY COMPARISON. Wenger, P. (Service Cantonal de Controle des Irradiations, Geneva); Bengtsson, L. G.; Dudley, R. A.; Godfrey, B. E.; Karniewicz, W.; Lenger, V.; Newton, D. Health Phys., 14: 209-22(Mar. 1968).

The radioactivity of two persons occupationally exposed to both ^{90}Sr and ^{226}Ra was measured at seven laboratories using whole-body counters. In addition to ^{40}K and ^{137}Cs, ^{90}Sr and members of the ^{226}Ra series were found in both individuals in amounts corresponding to 30–100% of the maximum permissible burdens (2 μCi ^{90}Sr, 0.1 μCi ^{226}Ra). The techniques used for the measurements, and the results obtained, are compared. Satisfactory agreement was ultimately established between the various centers, and it is concluded that in such persons the amounts of ^{90}Sr, ^{214}Bi, ^{40}K, and ^{137}Cs can be determined with an accuracy of 10–20%. (auth) (UK)

28484 INDICATION AND CONTRA-INDICATION OF THE USE OF RADIOACTIVE ISOTOPES. Hernady, Tibor. Magy. Radiol., 20: 36-47(1968). (In Hungarian).

Data are presented on the radiation dose to man during diagnostic radioisotope scanning using bismuth-206, chromium-51, cobalt-60, gold-198, iodine-131, iron-59, mercury-203, phosphorus-32, rubidium-86, selenium-75, sulfur-35, strontium-85, or technetium-99. The effects of various carriers for retention of radioisotopes in the body are discussed. Energy levels necessary for satisfactory scans are also considered. It is concluded that radioisotopes with a short biological half-life should be used to reduce the radiation dose to man during scanning. (C.H.)

28485 CONSTRUCTION OF A MATHEMATICAL MODEL FOR EFFECTIVE DOSES UNDER VARIOUS CONDITIONS OF CHRONIC IRRADIATION. Markelov, B. A.; Popova, N. A.; Filippov, V. A. (Inst. of Medical and Biological Problems, Moscow). Radiobiologiya, 7: 491-7(1967). (In Russian).

Two formulas were derived for calculating the effective dose at the beginning and end of chronic irradiation. With them a preliminary estimate could be made of the level of injury of the organism under different conditions of irradiation. When the significant features of the initial biological assumptions were considered the model could be used for prognosis in planning experiments. (JPRS)

28486 HAZARDS OF RADIATION FROM X-RAY EXPOSURE. Hicks, Hardy Henson (Hughes Building, Pampa, Tex.). J. Amer. Dent. Ass., 75: 1194-5(Nov. 1967).

The experience of a dentist who developed extensive x-ray-induced burns of the hands, requiring finger amputations and resulting in malignancy, is recounted. Proper x-ray procedures to ensure the safety of the dentist and his patients are stated. It is suggested that ignorance and negligence were responsible for the burns and, subsequently, the loss of both thumbs. He was unaware (in the 1920's) of scattered rays or the danger of assisting a patient in holding the x-ray film in position. With the early equipment he used, the exposure time to radiograph the teeth in the posterior region of mandible and maxilla required nine sec, whereas today, only one sec is required for adequate exposure. Photographs are provided to show the beginning of the lesions and the progression of the burns. A graft on the one thumb was unsuccessful because the surgery was not extended into normal tissue; therefore, additional surgery was necessary. Biopsies of the lymph nodes in the elbow and axillary region revealed cancer. (BBB)

28487 CONTAMINATION OF THE DIET BY RADIOACTIVE FALLOUT. Cramer, Nils. Phys.-Diaet. Ther., 5: 18-21(Jan. 1964). (In German).

Levels of contamination of various foodstuffs with fallout products such as ^{90}Sr and ^{137}Cs, as represented by vegetable and animal products from areas of the U. S., Iceland, Thailand, and Germany are reviewed. Values quoted range from 0.1 μCi ^{90}Sr/g Ca to as high as 220 μCi ^{90}Sr/g Ca. The significance of contamination from fallout is considered in terms of dietary habits, Ca requirements of various populations, food preferences, probable transfer chains, and degree of contamination as based on theoretical population food intake. As estimated, the radiation burden in man from synthetic sources may be from 10 to 20% of the environmental irradiation burden. It is concluded that in comparison to other hazards to which large human populations are exposed, contamination with radioactive fission products represents generally a minor factor so far. (BBB)

28488 RADIATION BARRIERS. Richards, Albert G. Oral Surg., Oral Med., Oral Pathol., 25: 701-7(May 1968).

Five examples are given of the computations involved in determining the proper thicknesses of primary radiation shields for x-ray equipment used for dental radiography. The total number of films exposed was the same in each example, but the time of exposure and hence the work loads were different because various combinations of film speed, kilovoltage, and target-film distances were employed. It was found that the use of higher-speed films permitted the thickness of the primary radiation shields to be decreased, while increases in either the tube voltage or the target-film distance required thicker primary radiation shields. A brick wall, which afforded adequate protection against primary radiation exposure when the x ray machine was operated at 70 kVp with either the short or the long cone, was no longer adequate when the same number of exposures was made at 100 kVp, regardless of the cone length. The required thickness of primary radiation shields proved to be dependent upon the target-film distance, tube voltage, and film speed. (auth)

28489 RADIOLOGICAL HEALTH ASPECTS OF OIL WELL LOGGING. Geiger, N.; Moore, R. T. Public Health Rep. (U. S.), 81: 1064-70(Dec. 1966).

A review is presented of the health hazards involved in using radioactive sources for logging oil wells, i.e., analyzing the geologic strata through which the well is drilled. The size of the sources used, the nature of the isotopes, and the conditions under which they are employed are factors that must be considered in making a radiation survey of field practices employed by a logging company. Plutonium-beryllium neutron sources are potentially less hazardous than radium-beryllium sources; however, radiation exposure can, in both cases, easily exceed the maximum permissible dose to workmen if precautions are not carefully followed. Since relatively large sources of radium and by-product materials are used under field conditions, widespread contamination could result from an accident, and emergency procedures as well as normal operating procedures should be established by the logging companies. (Occup. Safety and Health Abstr.)

28490 A STUDY TO DETERMINE THE EFFECTS OF INCREASING THE EXCHANGE INTERVAL FOR PERSONNEL DOSIMETRY FILMS. Campbell, R. O.; Lovell, P. K. (Sandia Corp., Livermore, Calif.). Amer. Ind. Hyg. Ass. J., 28: 354-6(July-Aug. 1967).

A study was conducted to determine the effects of extending the interval between the exchange of personnel dosimetry films from one month to three months. Unexposed and pre-exposed films from three exposure levels were stored in controlled and uncontrolled environments. A third of these films was removed and processed after one, two, and three months. Reported doses of the pre-exposed films were within the statistical variation (±15%) of the reported doses of films processed within four days after exposure. Unexposed films showed no fogging. (auth)

28491 ^{137}Cs BURDENS IN THE CANADIAN NORTH. Mohindra, V. K. (Dept. of National Health and Welfare, Ottawa, Can.). Acta Radiol., Ther., Phys., Biol., 6: 481-90(Dec. 1967).

Results of ^{137}Cs measurements in human urine and caribou meat samples from the Canadian North are presented for 1963, 1964 and 1965. Estimates of body burdens were made from ^{137}Cs concentrations in urine specimens. The average body burden of the people consuming relatively large quantities of caribou and reindeer meat were respectively 0.14 μCi, 0.40 μCi, and 0.56 μCi for those years. The highest level observed corresponds to a body burden of 3.2 μCi. It was comparatively higher in the eastern and central regions than in the western regions. (auth)

28492 FIELD MEASUREMENT OF ULTRAVIOLET, INFRARED, AND MICROWAVE ENERGIES. Fanney, Julius H. Jr.; Powell, Charles H. Amer. Ind. Hyg. Ass. J., 28: 335-42(July-Aug. 1967).

The industrial hygienist has for some time been aware of the possible hazards which exist from the energies in the non-ionizing portion of the electromagnetic spectrum. Potential sources of these radiations and instrumentation available for field measurement are reviewed. The instruments by categorical types, their advantages, disadvantages, and specificity for various portions of the spectrum, as well as the interpretation of their responses are discussed. Field survey techniques for specific sources and/or energies are also presented. The needs are stated for continuing research on instrumentation with recommendations related to spectral response and reliability. (auth)

28493 INSTRUCTION OF AUXILIARY PERSONNEL WORKING IN AREAS EXPOSED TO RADIATION. CLEANUP OPERATIONS IN ISOTOPE LABORATORIES. Voit, Endre. Atomtech. Tajek., 10: 527-31(1967). (In Hungarian).

In view of the ever-increasing number of employees in laboratories that work with radioactive materials, special attention must be devoted to the protection of auxiliary personnel, such as chauffeurs, craftsmen, and technicians who do not possess advanced technical knowledge. There is no need to give them detailed instruction in the physical problems involved in the interaction of radiation with matter. The basic principles of protection against radiation must be emphasized: increase of the distance between the radiation source and the worker; placement of a shield between them, and reduction of the duration of the exposure. The syllabus should be indicated in the personnel folder of the workers who should be asked to sign it. Personnel engaged in cleanup and

janitorial activities are especially exposed to the risk of contamination; the supervisors must be responsible for the enforcement of administrative safeguards and for carrying out the necessary decontamination and cleanup operations. Dust removal and wet decontamination methods are reviewed. (TTT)

28494 RAPID MONITORING OF TRITIUM AND ^{14}C IN URINE. Doremus, K. R.; O'Brien, M. G.; Meriwether (Merck and Co., Inc., Rahway, N. J.). Amer. Ind. Hyg. Ass. J., 28: 488-90(Sept.-Oct. 1967).

A rapid screening or monitoring procedure for the radioisotopes tritium and ^{14}C is presented. This is utilized as a valuable supplement to film badges, dosimeters, and other personnel monitoring devices. Any possible damage that may result from accidental contact, spills, or faulty laboratory procedures leading to internal absorption can be estimated from this type of analysis. A simple mixing of urine and phosphor and measurement in a type of spectrometer that is usually available in most radiation laboratories is all that is needed for this test. (auth)

28495 DATA. Radiol. Health Data Rep., 7: 627-73(Nov. 1966).

The ^{89}Sr, ^{90}Sr, ^{137}Cs, ^{131}I, and ^{140}Ba content of milk in North America and Pan America during July, 1966 is presented by the national and international surveillance networks. The Connecticut, Indiana, Michigan, New York, Minnesota, and Pennsylvania Milk Surveillance Networks reveal the radioisotope content of milk samples during early 1966. The Connecticut Dept. of Health has estimated the monthly dietary intake of ^{89}Sr, ^{90}Sr, and ^{137}Cs, for June, 1965 to June, 1966 based on standard diets. The gross radioactivity content of surface waters in the United States is reported for May, 1966, along with the radioactivity content of California waters for July to Dec., 1966. Radioactivity surveillance networks report the gross radioactivity content of airborne particulates and precipitation in North America and Pan America during July, 1966. The Atomic Energy Commission reports environmental radioactivity levels at the Lawrence Radiation Laboratory, and Mound Laboratory during July to Dec., 1965 and announces no nuclear tests at its Nevada test site, but has recorded a nuclear test of Soviet origin and one of Chinese origin during Oct., 1966. (E.R.B.)

28496 FILM BADGE SERVICE PERFORMANCE. Barber, D. E. (Univ. of Michigan, Ann Arbor). Radiol. Health Data Rep., 7: 623-6(Nov. 1966).

Approximately 2,000 film badges were irradiated with various types and energies of radiation to provide measures of film badge service accuracy upon which provisional performance control limits could be based. Exposures ranged from 2 mR to 497 R. Film badge services helped design the test procedures, submitted badges for exposure, reported exposure interpretations, and assisted in determining provisional performance control limits. A measure of accuracy called an error factor was determined for each service for each type and energy of radiation in the test. These error factors are tabulated to show the accuracy of the film badge services tested. Frequency distributions of the error factors served as the basis for selection of provisional control limits to be used to define acceptable performance. (auth)

28497 MEASUREMENTS OF 6 MV X RAYS. II. CHARACTERISTICS OF SECONDARY RADIATION. Karzmark, C. J.; Capone, Tatiana (Stanford Univ., Palo Alto, Calif.). Brit. J. Radiol., 41: 222-6(Mar. 1968).

Results are reported from measurements of secondary radiation from 6 MV x rays scattered from either a Presdwood phantom or a concrete barrier. The magnitude, angular distribution, and attenuation characteristics of these secondary radiations are discussed. The relative dose from radiation scattered by a Presdwood phantom was evaluated at 1 m from the phantom. Expressed as a percentage of the dose at the center of the phantom it varied from 0.04% at 135 degrees to 0.8% at 15 degrees. Expressed as a tenth-value thickness the attenuation thickness for this scattered radiation in concrete varied from 14.7 cm at 135 degrees to 33.3 cm at 15 degrees. The attenuation of 90 degree scatter was also investigated for Presdwood, steel, and lead. The 90 degree scatter had a monochromatic equivalent energy of slightly less than 500 keV. The intensity and angular distribution of scatter from a concrete barrier was examined for both 90 and 60 degree incidence of the primary beam. For these measurements the scattered dose at 1 m did not exceed 0.25% of the dose maximum just below the barrier surface for a 48 × 48 cm field. (auth)

28498 MEASUREMENTS OF 6 MV X RAYS. III. CHARACTERISTICS OF LEAKAGE RADIATION. Capone, Tatiana; Karzmark, C. J. (Stanford Univ., Palo Alto, Calif.). Brit. J. Radiol., 41: 227-30(Mar. 1968).

Measurements are reported for leakage radiation emerging from the x-ray target housing of a 6 MeV linear accelerator. Film dosimetry was extensively used to study leakage radiation and served to guide improvements in x ray head shielding. An ionization chamber study of the leakage component confirmed the film results and provided intensity profiles in three orthogonal planes passing through the target. The ionization chamber was also used to measure leakage radiation attenuation and to establish a profile of the useful beam and the penumbral region. For one representative operating condition the leakage and total scatter magnitudes rarely differed by more than a factor of 2 in the therapy room. (auth)

28499 NUCLEAR POWER PRODUCTION AND ESTIMATED ^{85}Kr LEVELS. Coleman, J. R.; Liberace, R. (Public Health Service, Rockville, Md.). Radiol. Health Data Rep., 7: 615-21 (Nov. 1966).

Worldwide environmental levels of ^{85}Kr were projected to the year 2060, based on published estimates of population increase and prediction of world power needs. Factors considered included estimates of the growth of nuclear reactor power as a fraction of total power production based on population growth and per capita power consumption, the mix of the reactor economy (thermal, thermal converter, and fast breeder systems), and the decay rate of ^{85}Kr inventory. Krypton 85 buildup is discussed in relation to population dose and also to the possible effect of ^{85}Kr contamination on the uses of noble gases. (auth)

28500 PLUTONIUM IN ENVIRONMENTAL AND BIOLOGICAL MEDIA. Magno, P. J.; Kauffman, P. E.; Shleien, B. (Northeastern Radiological Health Lab., Winchester, Mass.). Health Phys., 13: 1325-30(Dec. 1967).

Data are presented on the concentrations of plutonium in air, precipitation, total diet, milk and human tissue samples collected in the United States during the period 1964–1966. These data show that ^{239}Pu in monthly composites of particulates collected from surface level air in Winchester, Massachusetts ranged from 0.047 to 0.437 fCi/m^3 from May 1965 to April 1966, and that the average ^{239}Pu to ^{90}Sr ratio was 0.019 and the average ^{238}Pu to ^{239}Pu ratio was 0.04. Monthly deposition of ^{239}Pu from precipitation over the same period ranged from 0.86 to 8.8 pCi/m^2. Children's diets collected from six widely spaced geographical areas showed average concentrations which ranged from 2.7 to 5.8 fCi/kg for monthly samples for the period July–December 1965. Milk samples collected in a similar manner over a similar period showed concentrations which were not significantly different from zero. Analyses of human tissue samples obtained at autopsy in the greater Boston area during the period August 1965–July 1966 showed concentrations of ^{239}Pu in livers ranging from 0.21 to 2.52 pCi/kg and in lungs ranging from 0.14 to 1.13 pCi/kg. ^{239}Pu was not detected in bone samples from individual autopsies, but was detected in large composite bone samples in concentrations ranging from 0.04 to 0.12 pCi/kg. (auth)

28501 URANIUM LEVELS IN HUMAN DIET AND BIOLOGICAL MATERIALS. Welford, George A.; Baird, Ruth (Health and Safety Lab., New York). Health Phys., 13: 1321-4(Dec. 1967).

The uranium in typical adult diets in New York City, Chicago, and San Francisco was measured to determine body intake levels. Air, water, lung, and urine samples were also analyzed for uranium content. The diet data indicate uniform intake of uranium at the three sites examined. The values found were 1.3, 1.4, and 1.3 μg of uranium per day for New York City, Chicago and San Francisco, respectively. Based on these values, uranium excreted in urine by inference would be approximately 0.007 μg/l. The measured urinary excretion levels for non-exposed adults in the Chicago area indicate a range of values within the previously reported New York levels of from 0.03 to 0.3 μg/l. (auth)

28502 DATA. Radiol. Health Data Rep., 7: 561-613(Oct. 1966).

The ^{89}Sr, ^{90}Sr, ^{137}Cs, ^{131}I, and ^{140}Ba content of milk in North America and Pan America during June 1966 is presented by the national and international milk surveillance network. The Colorado, Florida, Oklahoma, and Texas Milk Networks report the ^{131}I, ^{137}Cs, ^{89}Sr, ^{90}Sr, and ^{40}K content of milk during April to June 1966. The radioactivity content of institutional diets in the United States during Jan. to March 1966 is reported as is the gross radioactivity content of surface waters in the United States during April 1966. The gross beta-radioactivity content of airborne particulates and precipitations in North America and Pan America during June 1966 are reported. Data are presented on the ^{90}Sr content of human bone in the United States during July to September 1965 and the ^{131}I content of bovine thyroid in the United States during July to Dec. 1965. The Atomic Energy Commission publishes environmental radioactivity levels for its installations at Bettis Atomic Power Laboratory, Feed Materials Production

Center, Knolls Atomic Power Laboratory, and S1C Prototype Reactor Facility during July to Dec. 1965, and announces three underground nuclear tests at its Nevada Test Site during Sept. 1966. (E.R.B.)

28503 PRECISION AND SENSITIVITY OF GAMMA SPECTROMETRIC MEASUREMENTS IN MILK. Wall, M. A.; Goldin, A. S. (Public Health Service, Winchester, Mass.). Radiol. Health Data Rep., 7: 555-9(Oct. 1966).

The sensitivity and precision of a gamma spectrometric laboratory for routine milk samples comprising four similar detector-analyzer systems was studied, utilizing the results obtained on environmental fluid milk samples. The sensitivity of the system was evaluated by measurements of ^{131}I concentrations, mostly at the zero counting level. The precision of the system was measured on the basis of replicate determinations of potassium and ^{137}Cs at higher counting levels. At all levels studied, variability was not significantly different from that calculated from radioactivity statistics. Only at the highest level encountered was there any indication of a greater variability than would be expected on a statistical basis, and even at this level the difference was not significant at the 95% confidence level. (auth)

28504 DIGEST OF PROTECTION STANDARDS AND STATE REGULATIONS FOR RADIOACTIVITY IN WATER. Hickey, J. L. S. (Public Health Service, Rockville, Md.). Radiol. Health Data Rep., 7: 549-54(Oct. 1966).

Numerical limits of seven published standards and guides for ^{226}Ra, ^{90}Sr, and unidentified radioisotopes in water for various applications and population groups are summarized. Of the 54 States and Territories, 47 have legislation or regulations for control of radioisotopes in water. Of these, 31 have adopted some form of numerical limits for control of radioisotopes in water. Sixteen States and Territories have general legislation permitting control of radiation exposure but no numerical limits for radioisotopes in water, and seven have no specific legislation for control of radioisotopes in water. (auth)

28505 FALLOUT FROM THE THIRD CHINESE NUCLEAR TEST: MAY 9, 1966. Grundy, R. D.; Snavely, D. R. (National Center for Radiological Health, Washington, D. C.). Radiol. Health Data Rep., 8: 301-16(June 1967).

Fresh fission products debris was detected in the United States in selected environmental media following the third Chinese atmospheric nuclear detonation of May 9, 1966. Peak concentrations in air, precipitation deposition, bovine thyroids, and milk, occurred in the Central and Southern States. Levels of ^{131}I in milk as observed by four State sampling programs and 18 U. S. Public Health Service Pasteurized Milk Network stations provided the basis for calculating ^{131}I pasture weathering half-times of four to 58 days. A peak ^{131}I milk concentration of 920 pCi/liter was observed in Arkansas on May 21, 1966. The resultant cumulative ^{131}I intake at this location based upon an assumed daily milk consumption of one liter, was calculated to correspond to 1.7% of the Protective Action Guide as established by the Federal Radiation Council. (auth)

28506 PLUTONIUM AND ^{90}Sr IN PRECIPITATION, AUGUST 1966 THROUGH MARCH 1967. Levine, H.; Kirk, W. P.; Rechen, H. J. L. (National Center for Radiological Health, Rockville, Md.). Radiol. Health Data Rep., 8: 574-6(Oct. 1967).

The national and international milk surveillance networks announce the ^{89}Sr, ^{90}Sr, ^{137}Cs, ^{131}I, and ^{140}Ba content of milk samples in North America and Pan America during June, 1967, and Colorado, Florida, Oklahoma, Tennessee, and Texas milk surveillance agencies present the data for April to June, 1967 on the radioisotope content of local milk samples. An annual summary for 1966 is presented along with data for Jan. to March, 1967 on the ^{89}Sr, ^{90}Sr, ^{137}Cs, and ^{226}Ra content of institutional diets in the United States, and the estimated daily intake of these radioisotopes in the diet of Californians during Sept., 1966 to Feb., 1967 is presented. Average alpha- and beta-radioactivity levels of surface waters in the United States during April, 1967 and of the Minnesoto water supply during July to Dec., 1966 are given. The radioactivity levels in airborne particulates and precipitation in North America and Pan America during June 1967 are given. The Atomic Energy Commission reports the environmental radioactivity levels at the following installations: Bettis Laboratory, Knolls Laboratory, and the S1C Prototype Reactor Facility, and announces three underground nuclear tests at the Nevada Test Site during Sept., 1967. A special note is included on the plutonium isotope and ^{90}Sr content in precipitation in the United States during Aug., 1966 to March, 1967. (E.R.B.)

28507 RADIOACTIVITY IN DRINKING WATER IN THE UNITED KINGDOM: 1965 RESULTS. J. Brit. Waterworks Ass., 49: No. 424, 27-33(Jan. 1967).

Samples taken regularly from 26 public drinking water supplies were analyzed for concentrations of ^{90}Sr and ^{137}Cs. The average daily ingestion per person in 1965 was estimated to be 0.95 pCi for ^{90}Sr and 0.19 pCi for ^{137}Cs. (Pub. Health Eng. Abstr.)

28508 DATA. Radiol. Health Data Rep., 8: 139-90(Mar. 1967).

Data are presented on the routine monitoring of the ^{89}Sr, ^{90}Sr, ^{131}I, ^{137}Cs, and ^{140}Ba content of milk by the Pasteurized Milk Network, and the Pan American Milk Sampling Program for November 1966. Data are also presented on the ^{90}Sr content of milk in New York City during Jan. to June 1966. State milk surveillance activities are given for California, Oregon, and Washington indicating the radioisotope content of milk during July to Sept. 1966. Five food and diet surveillance activities are reported that are useful in estimating the national dietary intake of radioisotopes during 1965. The gross radioactivity in surface waters of the United States during Sept. 1966 is presented from a nationwide network of monitoring stations. Radioactivity in airborne particulates and precipitation is also under continuous surveillance, and data are presented from this network throughout North America and Pan America for Nov. 1966. Other data are presented on regional studies of the ^{90}Sr content of human bone during April to June 1966, and the environmental levels of radioactivity at selected Atomic Energy Installations including Argonne National Laboratory, Atomics International, Feed Materials Production Facilities, and National Reactor Test Station are given for 1966. The Atomic Energy Commission reported three underground nuclear tests of low to intermediate yield during Feb. 1967, at their Nevada Test Site, and seismic readings indicate one nuclear test of Russian origin during Feb. 1967. (E.R.B.)

28509 NUCLEAR PROCESSES DO OCCUR IN LIVING TISSUE? Wszolek, B. (J. Strus City Hospital, Poznan, Poland); Kukiel, E.; Konarski, J. M. Acta Phys. Pol., 32: 323-6(1967).

Use of the nuclear plate technique in studies on the mechanism of biological activity of mammalian tissues, led to the observation of nuclear phenomena. These nuclear processes were initiated by deuterons and neutrons with nuclei of the plate emulsion. Substrates for the nuclear plates were tissues of kidney carcinoma and liver tumor from rats. Some plates contained lithium borate. Samples of each of the water free homogenates were exposed in light-tight boxes under 3 cm of lead and ca 2.5 m under the earth's surface at 278 ± 2°K for six weeks. During subsequent processing of the exposed plates, only those tracks resulting from distinctly nuclear disintegration or other nuclear processes were measured. Evidence was present in the exposed plates for the disintegration of ^{6}Li nucleus following capture of a slow neutron, and the disintegration of a ^{14}N nucleus caused by a deuteron. These phenomena, as well as the presence of many protons were recorded on all of the exposed plates. Careful examination of the control plates failed to disclose any nuclear phenomena. The following observations were made concerning the obtained results; the number of tracks varied with time elapsed between sacrifice of the rat and plate exposure of the tissue, and some of the same nuclear phenomena were observed when plates were exposed with leaves of test plants infected with TMV. The theoretical interpretation of the observed events may be based on the energy transfer between an excited electronic shell and nucleus. (E.R.B.)

28510 DATA. Radiol. Health Data Rep., 8: 425-89(Aug. 1967).

Data are presented by national and international milk surveillance networks on the ^{89}Sr, ^{90}Sr, ^{137}Cs, ^{131}I, and ^{140}Ba content of milk in North America and Pan America during April 1967, and by Connecticut, Indiana, Iowa, Michigan, Minnesota, New York, and Pennsylvania milk surveillance agencies on the radioisotope content of local milk samples during Jan. to March 1967. Gross radioactivity levels in surface waters of the United States during Feb. 1967, ^{90}Sr levels in surface waters of the United States during Oct. 1965 to June 1966, and radioactivity levels in surface waters of Washington State during July 1965 to June 1966 are reported. The radioactivity content in airborne particulates and precipitation in North America and Pan America during April 1967 are given. Data are presented on the ^{131}I content of bovine thyroids during Jan. to March 1967 by the Public Health Service. The Atomic Energy Commission published data on the environmental radioactivity at the following installations during July to Dec. 1966; Atomics International, Feed Materials Production Center, and Oak Ridge Area. The AEC also announced one underground nuclear test at Nevada Test Site during July 1967. Technical notes are published on gross beta-radioactivity in Fucus hybrids in Connecticut during 1961 to 1964, radioactivity levels in the atmosphere in Galveston during 1966, radioactive material handling problems in oil and gas well logging. (E.R.B.)

28511 UPTAKE OF ^{137}Cs FROM CONTAMINATED SOIL BY SELECTED GRASS CROPS. Cromroy, H. L.; Goldsmith, W. A.;

Phillips, C. R.; Bonner, W. P. (Univ. of Florida, Gainesville). Radiol. Health Data Rep., 8: 421-4(Aug. 1967).

The ^{137}Cs content of milk in the Tampa, Fla., area was consistently above the national average in recent years. The possibility that grasses grown in this area receive their contamination indirectly through contaminated soil is being investigated. Among the grasses investigated the uptake of ^{137}Cs appears to be greatest for pangola grass. (auth)

28512 ^{90}Sr IN HUMAN BONES, 1964–1965. Hallisey, R. M.; Wall, M. A. (Northeastern Radiological Health Lab., Winchester, Mass.). Radiol. Health Data Rep., 8: 415-19(Aug. 1967).

Results obtained from analysis of ^{90}Sr in human bone specimens from 303 individuals who died in 1964, and 293 individuals who died in 1965 were studied. The bone specimens were collected at autopsies in selected metropolitan cities throughout the United States. A summary table of all the data for deaths occurring in 1964 and 1965 is presented. In most of the five age groups in 1965, average values are slightly lower than the 1964 values. Regional variations in the ^{90}Sr to calcium ratio are shown with the highest average for each year in the Delta region. The data were related to human bone concentrations that were derived from the Federal Radiation Council's Radiation Protection Guides and intake ranges, and it was shown that in both years the average bone concentrations correspond to Range I of these intake guides. (auth)

28513 ^{239}Pu IN TOTAL DIET AND MILK. Kauffman, P. E.; Magno, P. J. (Public Health Service, Winchester, Mass.). Radiol. Health Data Rep., 8: 191-4(Apr. 1967).

The National Center for Radiological Health initiated a program in July 1965 to determine the level of ^{239}Pu in the total diet and milk. The diet samples were obtained from the Institutional Total Diet Sampling Network of the Public Health Service and the milk samples were obtained from the PHS Pasteurized Milk Network. Using a gastrointestinal absorption factor of 3×10^{-5} as suggested by the International Commission on Radiological Protection, the average amount of ^{239}Pu reaching the blood stream from the diet is estimated to be 2×10^{-4} femtocuries per day. (auth)

28514 DATA. Radiol. Health Data Rep., 8: 317-54(June 1967).

Data are presented by national and international milk surveillance networks on the ^{89}Sr, ^{90}Sr, ^{137}Cs, ^{131}I, and ^{140}Ba content of milk in North America and Pan America during Feb. 1967 and by the California, Oregon, and Washington state milk surveillance agencies on the radioisotope content of local milk samples during Oct. to Dec. 1966. The average dietary intake of ^{90}Sr by inhabitants of New York City, San Francisco, and Chicago during May to July 1967 is given. Data on the gross radioactivity of surface waters in the United States during Dec. 1966, of California waters during Jan. to June 1966, and on ^{90}Sr content of tap water in New York City during March to Nov. 1966 are given. Gross beta-radioactivity of airborne particulates and precipitation in North America and Pan America during Feb. 1967 is reported. The Atomic Energy Commission reports the environmental radioactivity levels at the following installations; Brookhaven National Laboratory, and the Lawrence Radiation Laboratory, and announces four underground nuclear tests at the Nevada Test Site during May 1967. A technical note is included on a full-scale ^{90}Sr removal system for fluid milk. (E.R.B.)

28515 A PHOSPHOR-FILM TECHNIQUE TO DETERMINE THE ACTIVITY OF INDIVIDUAL PARTICLES ON AIR SAMPLE FILTERS. Sherwood, R. J.; Stevens, D. C. (Atomic Energy Research Establishment, Harwell, Eng.). Ann. Occup. Hug., 11: 7-12(Jan. 1968).

The autoradiographic technique described for α-emission using a zinc sulfide scintillator screen and light sensitive plate is sufficiently sensitive and rapid for use in measuring the number and activity of dust particles present on an air sample filter. If it is desired to distinguish between a sample which has collected 10 particles of roughly equal activity and a sample which has collected only one particle (taking a lower limit of 10 particles as a statistically significant sample of an airborne cloud), then a minimum sample activity of 10 dis/min is required for an overnight exposure or 1 dis/min for an exposure of 1 week. In the case of β emission, the simple x-ray emulsion technique is more sensitive. When samples are both α and β active it is suggested that the filter is mounted dust side up on the emulsion surface of an N40 plate, and the Melinex, phosphor, and another N40 plate applied as described. The lower plate will then record only the β active particulates and the upper plate both the alpha and beta active particles. (auth) (UK)

28516 RADIONUCLIDE LEVELS IN MILK, TOTAL DIET, AND HUMAN BONE COMPARED TO FEDERAL RADIATION COUNCIL ESTIMATES, 1965, AND 1966 ESTIMATES. Grundy, Richard D. (National Center for Radiological Health, Rockville, Md.). Radiol. Health Data Rep., 8: 65-72(Feb. 1967).

Estimates of the levels of fallout radioisotopes in environmental media and in human bone expected from 1963 through 1965 were made by the Federal Radiation Council. The 1965 observed values are compared with the FRC predictions and 1966 levels are estimated using the approach proposed by the Federal Radiation Council. The observed radioisotope levels are in agreement with the prediction made by the Federal Radiation Council. The observed levels and the predicted levels of radioactivity in food over the next several years are too small to justify protective action to limit the dietary intake of radioisotopes. (auth)

28517 DATA. Radiol. Health Data Rep., 8: 251-99(May 1967).

National and international surveillance networks report the ^{89}Sr, ^{90}Sr, ^{137}Cs, ^{131}I, and ^{140}Ba content of milk samples in North America and Pan America during Jan. 1967, and the Connecticut, Indiana, Michigan, Minnesota, New York, and Pennsylvania milk surveillance networks report the radioisotope content of local milk samples for Oct. to Dec. 1966. The ^{89}Sr, ^{90}Sr, and ^{226}Ra content of the daily human diet in California during May to Aug. 1966 is given as is the estimated daily dietary intake of ^{89}Sr, ^{90}Sr, and ^{137}Cs in Connecticut during July to Dec. 1966. The gross radioactivity levels of surface waters in the United States during Nov. 1966 and the gross radioactivity levels in airborne particulates and precipitations in North America and Pan America during Jan. 1967 are given. Data are presented on the ^{89}Sr, ^{90}Sr, and ^{137}Cs content in Alaskan caribou and reindeer during Oct. and Nov. 1966. The Atomic Energy Commission published the environmental radioactivity levels at its Mound, and Rocky Flats sites and announced three underground nuclear tests at its Nevada Test Site during April 1967. A report is also given of the alpha-, beta-, and gamma-radioactivity levels in Texas commercial oysters during 1965 and 1966. (E.R.B.)

28518 RADIATION HAZARDS FROM X-RAY DIFFRACTION EQUIPMENT. Howley, J. R.; Robbins, C. (National Institutes of Health, Bethesda, Md.). Radiol. Health Data Rep., 8: 245-9(May 1967).

Improper or careless use of x-ray diffraction equipment can cause severe burns to the upper extremities of the body of the operator. These burns are slow to heal and can lead to cancer. Cataracts and other opacities can be produced in the eye with a single exposure of 200 R. The use of inadequate survey equipment can lead to a gross underestimate of the hazard. Since serious injury from intense primary beam radiation can occur in a matter of seconds and the hazard from scattered radiation is also significant, the use of film badge monitoring alone can give a false sense of protection. Recommendations are given. (auth)

28519 DATA. Radiol. Health Data Rep., 8: 195-244(Apr. 1967).

National and International Milk Surveillance Networks report the ^{89}Sr ^{90}Sr, ^{137}Cs, ^{131}I, and ^{140}Ba content of milk samples in North America and Pan America during Dec. 1966, and the Oklahoma, Tennessee, and Texas Milk Surveillance Networks report the radioactivity levels of local milk samples during Oct. to Dec. 1966. The ^{89}Sr, ^{90}Sr, ^{137}Cs, and ^{226}Ra content of institutional diets in the United States during July to Sept. 1966 is reported by the Public Health Service. Gross radioactivity levels of airborne particulates and precipitations in North America and Pan America, and surface waters in the United States during October 1966 are reported. The Public Health Service reports the ^{131}I content of bovine thyroids in the United States during July to Dec. 1966. The Atomic Energy Commission published the environmental radioactivity levels at its Bettis Power Plant, Feed Materials Production Center, Knolls Laboratory, and S1C Prototype Reactor Facilities, and announced one underground nuclear test at its Nevada Test Site during March 1967. (E.R.B.)

28520 ^{90}Sr IN HUMAN BONE FROM INFANCY TO ADULTHOOD, 1962–1963. Gaffney, George W. (Baltimore City Hospitals); Hallisey, Robert M.; Miller, Marshall S.; Baratta, Edmond J. Radiol. Health Data Rep., 7: 383-6(July 1966).

Strontium-90 accumulation in the bones of children and adults through age 25 was analyzed by comparing the ^{90}Sr to calcium ratios found in specimens from selected age groups during the 1962 to 1963 portion of a continuing program. The highest mean ^{90}Sr to calcium ratios were found in the one to four yr olds, with the 1962 peak in the one yr olds (4.5 pCi/g) and the 1963 peak in the two yr olds (5.6 pCi/g). It is pointed out that the mean values for the group under one yr of age were relatively low (2.6 pCi/g in 1962; 1.8 pCi/g in 1963), but were obtained from a small number of samples. Average ^{90}Sr to calcium ratios in bone of older groups declined with increasing age and were least in the 20 to

25 yr age group. The data for each age group, although limited, appear to follow a log normal distribution, and it is suggested that this distribution is more suitable than a normal distribution as a basis for calculating the proportion of a population group in which a given body burden is unlikely to be exceeded. (auth)

28521 DISTRIBUTION OF STRONTIUM AND CALCIUM IN MAJOR VEGETABLE AND FRUIT CROPS AND CRITERIA FOR USE OF FALLOUT-CONTAMINATED FOODS. Ralls, J. W.; Primbsch, S.; Guckeen, T. R.; Maagdenberg, H. J.; Rinehart, J.; Lamb, F. C.; Mercer, W. A. (National Canners Association, Berkeley, Calif.). Radiol. Health Data Rep., 8: 355-8(July 1967).

Vegetable and fruit crops were grown in soil enriched with high levels of strontium nitrate. The normally edible portions of the crops were harvested and sectioned into anatomically distinct portions. The strontium and calcium content was measured by flame spectrophotometry or by photon activation analysis. The results are tabulated to provide an upper limit for radiostrontium content of crops grown in soil heavily contaminated with debris from nuclear fission on a massive scale. (auth)

28522 DATA. Radiol. Health Data Rep., 7: 387-425(July 1966).

Data are presented on the following varied activities: the ^{90}Sr and ^{137}Cs content of milk in North America and Pan America during March 1966, according to national and international surveillance stations reports on the radioactivity of milk samples during Jan. to March 1966 in Florida, Oklahoma, and Texas, the ^{90}Sr, ^{137}Cs, and ^{226}Ra content of institutional diets of children in the United States during Oct. to Dec. 1965, the gross radioactivity of surface waters in the United States during Jan. 1966, the beta-radioactivity of the Minnesota municipal water supply during July to Dec. 1965, the gross beta-radioactivity in airborne particulates and precipitation in North America during March 1966, and the environmental levels of radioactivity at Paducah Plant, Portsmouth Area Gaseous Diffusion and Shippingport Atomic Power Station during July to Dec. 1965. The Atomic Energy Commission reports five underground nuclear tests during June 1966. (E.R.B.)

28523 DATA. Radiol. Health Data Rep., 8: 375-413(July 1967).

Data from selected national, international, and state milk and food surveillance activities are presented. Data from the Pasteurized Milk Network survey are presented showing average concentrations of ^{89}Sr, ^{90}Sr, ^{131}I, ^{137}Cs, and ^{140}Ba in pasteurized milk during March 1967, and the first quarter of 1967. The Canadian Milk Network presented data on concentrations of ^{137}Cs and ^{90}Sr in Canadian whole milk during March 1967. Concentrations of ^{137}Cs and ^{90}Sr in milk during March 1967, in Pan American countries are also presented. Analyses and monitoring of radionuclides in milk were conducted by State Health departments as follows: ^{137}Cs and ^{131}I in Colorado; ^{137}Cs and ^{131}I in Oklahoma; ^{89}Sr, ^{90}Sr, ^{131}I, ^{137}Cs, and ^{140}Ba in Tennessee; and ^{40}K, ^{90}Sr, ^{131}I, and ^{137}Cs in Texas. Radionuclide concentrations in institutional diet samples during October to December 1966 are given to show intake of ^{89}Sr, ^{90}Sr, ^{137}Cs, ^{226}Ra, Ca, and K in the diet of children 9 to 12 yrs old. Gross alpha and beta radioactivity in surface waters of the United States during January 1967, was determined. Surveys were conducted to determine radioactivity in airborne particulates and precipitation. Tables are presented to show gross beta radioactivity in surface air and precipitation during March 1967, in the United States, Canada, Mexico, and South America. Human bone specimens were collected from various regions of the United States to obtain data on ^{90}Sr concentrations in bone samples from people of various ages during July to September 1966. Environmental levels of radioactivity at Atomic Energy Commission installations were determined for beta radioactivity and uranium content of air and water samples at Paducah during 1966, content of tritium in air and water at the Pinellas Peninsula Plant during July to December 1966, and content of tritium and radioactive waste, exclusive of tritium, discharged into the Ohio River from the Shippingport Atomic Power Station during July to December 1966. (H.L.W.)

28524 DIET MODEL FOR MEASURING RADIOACTIVITY EXPOSURE THROUGH FOOD: PILOT STUDY. Steinkamp, R. C.; Cohen, N. L.; Hutson, E.; Kunkel, H. (California State Dept. of Public Health, Berkeley, Calif.). Radiol. Health Data Rep., 8: 565-73(Oct. 1967).

This paper reports a pilot study designed to test the hypothesis that the house diet of a hospital may serve as a model for the diet of an adult population regionally served by the hospital in order to measure radioactivity exposure through food intake. Yearly and seasonal quantities of 37 subcategories of nine major food groups were compared for a Berkeley hospital house diet and diets of Berkeley and other San Francisco Bay Area residents. Results indicate that the hospital house diets while differing in certain respects from food intake of the population, may provide an estimate of near-maximum intake of foods significant for radioactive content. (auth)

28525 AERIAL MEASUREMENT OF THE KIWI TRANSIENT NUCLEAR TEST. Coleman, R. D.; Andrews, V. E. (Dept. of Health, Education, and Welfare, Las Vegas, Nev.). Radiol. Health Data Rep., 8: 359-66(July 1967).

The Los Alamos Scientific Laboratory conducted a Transient Nuclear Test on a KIWI Reactor on January 12, 1965, at the Nuclear Rocket Development Station at Jackass Flats, Nev. During this planned destructive test of a propulsion reactor, the Public Health Service's Southwestern Radiological Health Laboratory conducted a land and aerial offsite radiological surveillance program. The aerial aspects of the laboratory's program included sampling and assay missions along flight patterns through the radioactive cloud formed by the destruction of the reactor. Samples obtained from these aerial missions were analyzed to define various characteristics of the cloud. The aircraft made repeated measurements of peak gamma levels in the cloud. The decrease of peak gamma-ray readings with distance from the site of the experiment was exceptionally rapid. The reduction is attributed to a combination of decay and excellent meteorological diffusion. (auth)

28526 DATA. Radiol. Health Data Rep., 8: 79-135(Feb. 1967).

The ^{89}Sr, ^{90}Sr, ^{137}Cs, ^{131}I, and ^{140}Ba content of milk in North America and Pan America during Oct. 1966 is reported by the national and international milk surveillance networks, and the Connecticut, Indiana, Michigan, Minnesota, New York, and Pennsylvania Milk Networks report the ^{40}K, ^{90}Sr, ^{131}I, and ^{137}Cs content of local milk samples during July to Sept. 1966. The alpha- and beta-radioactivity of surface waters in the United States during August 1966 is reported by the Dept. of Interior, and the beta-radioactivity of airborne particulates and precipitation during Oct. 1966 is also reported. Data from routine sampling of ^{90}Sr content of human bone in the United States during Jan. to March 1966 is given. The Atomic Energy Commission reports environmental radioactivity levels during 1965 and 1966 at its Hanford, Pinellas Peninsula, Savannah River, and Shippingport sites, and announces two underground nuclear tests at the Nevada Test Site during Jan. 1967. (E.R.B.)

28527 TRITIUM IN SURFACE WATERS, 1964–1965. Chesnutt, M. W. (Div. of Radiological Health, Montgomery, Ala.); Drobinski, J. C. Jr.; Gorrie, R. H. Radiol. Health Data Rep., 7: 377-80(July 1966).

Concentrations of tritium in U. S. surface waters are reported for the period of May 1964 through December 1965. This is the initial report of a continuing surveillance program. The results show some differences in tritium concentrations in water samples from various parts of the country and as a function of time. The highest level observed (20.3 nCi/liter) is well below the occupational exposure guide (30 μCi/liter) and the guidance level requiring active surveillance (100 nCi/liter), calculated from the general guidance of the Federal Radiation Council. (auth)

28528 ^{90}Sr IN 1965 UNITED STATES WHEAT. Anderson, R. A.; Pfeifer, V. F. (Agricultural Research Service, Peoria, Ill.). Radiol. Health Data Rep., 7: 381-2(July 1966).

In continuing surveys of ^{90}Sr content of wheat, USDA studies indicate the U. S. weighted average concentration to be 95 pCi/kg, which compares well with the Federal Radiation Council's prediction for 1965 (88 pCi/kg). The 1965 average also confirms the predicted continuing downward trend seen in 1963 and 1964 averages—220 and 133 pCi/kg, respectively. Samples used to develop the 1965 average represented 52% of the U. S. wheat production and individual ^{90}Sr concentrations ranged from a low of 31 pCi/kg, in a soft white winter wheat from Washington, to a high of 174 pCi/kg in hard red winter wheat from Kansas. It was noted that the 1965 trends of high and low concentrations were similar to those of 1964. (auth)

28529 BETA-RAY EXTRACORPOREAL IRRADIATORS AFFORDING COMPLETE PATIENT MOBILITY. O'Foghludha, F.; Wolf, James S. (Medical Coll. of Virginia, Richmond). Radiology, 90: 371(Feb. 1968).

Ionization chamber and LiF thermoluminescent dose measurements at depths within phantoms exposed to orthovoltage x radiation and ^{60}Co γ radiation were compared. Good agreement was found for ^{60}Co γ depth dose measurements made with an ionization chamber and with a TLD-100 LiF detector. Similar agreement was not achieved for orthovoltage x-ray beams. Increased thermoluminescent response at low photon energies resulted in displacement of LiF depth-dose curves from those measured with

ionization chambers. Difficulties with surface dose measurements also contributed to errors in depth-dose curves. Mathematical corrections were found to be feasible for LiF measurements of depth dose from orthovoltage x-ray beams, but the influence of dose on LiF energy dependence complicated development of these corrections. (C.H.)

28530 CONSTRUCTION OF ISODOSE LINES FOR 6 MV X RAYS BY THE DECREMENT-LINE METHOD. Feldman, Arnold; Anderson, Joseph A.; Weber, Francis C.; Williams, Marvin M. D. (Mayo Clinic, Rochester, Minn.). Radiology, 90: 369-70(Feb. 1968).

The decrement-line method was used for construction of isodose curves for x rays generated by a 6 MV linear accelerator. A remote locator and a Victoreen rate meter ionization probe were used to determine locations having decrement values ranging from 0.970 to 0.05 at four or five depths for 10 fields. Good agreement was found between isodose curves constructed by use of decrement values and curves measured directly. The time required to construct isodoses by this method was less than that involved in direct measurement and could be further decreased by use of a digital computer. An additional advantage was that it was not necessary for the accelerator to be available after the basic measurements were made. (C.H.)

28531 GENETICALLY SIGNIFICANT DOSE TO THE UNITED STATES POPULATION FROM DIAGNOSTIC MEDICAL ROENTGENOLOGY, 1964. Penfil, Richard L.; Brown, Morton L. (National Center for Radiological Health, Rockville, Md.). Radiology, 90: 209-16(Feb. 1968).

A national survey including over 10,000 households and over 3,000 medical x-ray facilities produced data that were subjected to a proved indirect computer dosimetry system yielding gonad doses. These data were then utilized to estimate the genetically significant dose (GSD) to the United States population. The GSD for the United States population (1964) was found to be 55 millirads. This value is compared with estimates from other countries and with high levels of natural background radiation. The findings indicated that: 90% of the total genetically significant dose results from examinations of the abdomen and pelvis; 82% was contributed by examinations of males; and only 4% was contributed by fluoroscopic examinations. The data also revealed that beam size was frequently greater than film size. It was shown that if collimation were used to limit beam size to film size in the plane of the film, the GSD would be reduced from 55 to 19 millirads. (auth)

28532 GENETICALLY SIGNIFICANT DOSE TO THE POPULATION OF NEW YORK CITY FROM DIAGNOSTIC MEDICAL RADIOLOGY. A DOSIMETRIC AND STATISTICAL STUDY. Pasternack, Bernard S.; Heller, Mortimer B. (New York Univ. Medical Center). Contracts SAph 73722; PH86-65-24. Radiology, 90: 217-28(Feb. 1968).

With the use of collected field study data and a devised dose estimation procedure, the annual genetically significant dose (GSD) from diagnostic radiology in New York City physicians' private offices and in hospitals and clinics was estimated to be 50 mrad, a figure that is higher than most estimates recently made for the United States and foreign countries. Examinations performed in private offices contribute a proportionately greater share to GSD than those performed in hospitals. The present estimate reaffirmed diagnostic radiology to be the largest man-made contributor to GSD. (auth) (TSS)

28533 LiF DEPTH-DOSE MEASUREMENTS. Hendee, W. R.; Golden, R.; Garciga, C. E.; Gilbert, D. B.; Ibbott, G. S. (Univ. of Colorado, Denver). Radiology, 90: 371(Feb. 1968).

Beta ray extracorporeal blood irradiators are described that afford complete patient mobility. One irradiator consists of a wrist-borne bracelet to which ^{90}Sr sources, encapsulated in Al, can be attached in a matter of seconds after blood has begun to flow in the shunt. Beta irradiators were also constructed using ^{90}Y and ^{32}P as sources. One consists of a vinyl box-like container in which ^{32}P was chemically incorporated. The blood flows directly over the vinyl. Mean radiation doses for all shunts were measured with a modified Fricke dosimeter. (C.H.)

28534 MEDICAL RADIOLOGICAL PRACTICE IN NEW ORLEANS: ESTIMATES AND CHARACTERISTICS OF VISITS, EXAMINATIONS, AND GENETICALLY SIGNIFICANT DOSE. Izenstark, Joseph L.; Lafferty, Walter (William Beaumont Hospital, Royal Oak, Mich.). Contracts SAph 76720; PH 86-62-95; PH 86-65-28. Radiology, 90: 229-42(Feb. 1968).

The results of a prospective universal recording x-ray data collection study performed in the New Orleans area are presented. Each of 73 percent of the x-ray units in use for diagnostic radiography in the area was observed for four calendar weeks. Patients and x-ray technical factors were recorded at the time of x-ray exposure. From April 1, 1962, to March 31, 1963, estimates of 680,550 patient visits, 777,000 roentgenographic examinations, and 1,636 to 700 projections were obtained by combining the observed data with an examination of the year's x-ray log records in each location studied. Sixty percent of the roentgenographic work was performed in hospitals. Radiologists supervised 75 percent of the work and made 83 percent of the projections. An exception was photofluorography that was almost exclusively used by health agencies and nonradiologists. Radiologists generally required more projections per examination than nonradiologists but used smaller x-ray field areas. The character of radiologic practice has changed in the past decade, with a shift to more diagnostic roentgenography and relatively less fluoroscopy, photofluorography, and therapy. Yet the number of examinations per visit remains the same at 2.1. A mathematical model was developed that used technical data from which the skin and gonad exposures were calculated. The average skin and gonad exposures for various examinations are presented and compared to those of other studies. The results appear similar to values obtained with dosimeters, suggesting that the mathematical model might be used for future population studies. In New Orleans the genetically significant dose was calculated as 75.3 mR (males 31.5 mR; females 43.8 mR), one-third of which was due to obstetrical examinations. (auth) (TSS)

28535 ^{90}Sr IN FISH OF THE ATLANTIC AND INDIAN OCEANS. Parchevskii, V. P.; Sokolova, I. A.; Zabrunnova, I. S. Radiobiologiya, 7: 465-7(1967). (In Russian).

Determinations were made of the ^{90}Sr content of fish of various species caught during 1962–65 in the southern Atlantic and the north-western part of the Indian Ocean. The content of ^{90}Sr was in the range of 0.74–6.10 pCi/kg raw weight (0.13 to 1.09 Sr units). Because there was no significant difference between species of fish as far as accumulation of ^{90}Sr was concerned, the ^{90}Sr content for various species was averaged out in the statistical evaluation. The evaluation of data for 1965 showed that there was no statistically valid difference between the ^{90}Sr content in fish of the Atlantic and Indian Ocean, which amounted on the average to 2.60 and 3.81 pCi/kg raw weight, respectively. (JPRS)

28536 CODE OF PRACTICE FOR USE OF X-RAY EQUIPMENT IN MEDICAL DIAGNOSIS. Sydney, Department of Public Health, 1966. 12p.

A guide to safe practice in the use of medical diagnostic x-ray equipment covering such matters as responsibility and qualifications of personnel, safety rules for radiography and fluoroscopy (equipment, exposure of patients and staff) and personnel monitoring in New South Wales is presented. The code is not statutory, but defines the principal safety standards used by the Radiation Branch as a basis for assessing the radiological health aspects of applications for license under the New South Wales Radioactive Substances Act. (Occup. Safety and Health Abstr.)

Medicine

Refer also to abstracts 27963, 28071, 28228, 28281, 28325, 28330, 28384, 28408, 28440, 28461, 28474, 28479, 28484, 28531, 28532, 28534, 28622, 28631, 28632, 28646, 28648, 28681, 28712, and 29807.

28537 (ANL-7278, pp 170-84) RADIATION PROTECTION. (Argonne National Lab., Ill.).

PLUTONIUM—removal of polymerized, from bone and liver of mice by DTPA and EDTA; distribution of polymerized, in bone marrow, kidney, liver, and spleen of mice following intravenous injection

ALPHA PARTICLES—detection and measurement of plutonium, using liquid scintillation spectrometer

BONES—isolation of mucopolysaccharides and mucoproteins from calf; radioinduced tumors in, of mice, protective effects of DTPA against α

CARTILAGE—isolation of mucopolysaccharides and mucoproteins from calf; phosphorus content of, comparison of ossifying and resting

PROTOZOA—Pelomyxa palustris, electron microscopy of; Amoebae sp., preparation of homogenate culture media for; Pelomyxa illinoisensis, radiation effects on survival of, effects of actinomycin D on x; Pelomyxa illinoisensis, radiation effects on survival of, protective effects of injections of unirradiated protoplasm against x (H.L.W.)

28538 (NYO-2147-13, pp 78-86) COMPARISON OF RESIN SPONGE UPTAKE OF TRIIODOTHYRONINE-^{131}I FROM SERUM WITH OTHER COMMONLY USED THYROID FUNCTION TESTS AS INDICATION OF THYROID DYSFUNCTION IN THE DOG. (New York State Veterinary Coll., Ithaca. Dept. of Physical Biology).

The resin sponge uptake of triiodothyronine ^{131}I (T-3^{131}) from

dog serum was compared with cholesterol level, thyroid uptake of ^{131}I and the protein-bound ^{131}I conversion ratio ($PB^{131}ICR$) in a group of beagle dogs. The normal $T\text{-}3^{131}$ uptake is approximately 50.0 + 8% (95% confidence limits). Results of the other tests compare favorably with previously reported values. The advantages of the T-3 test as a practical clinical diagnostic test are discussed. (auth)

28539 (NYO-2147-13, pp 87-94) BLOOD ^{59}Fe AND ^{51}Cr KINETICS IN NORMAL HORSES FOR COMPARISON WITH HORSES INFECTED WITH EQUINE INFECTIOUS ANEMIA. Kallfelz, F. A.; Craig, P. H. (New York State Veterinary Coll., Ithaca. Dept. of Physical Biology).

Several parameters of hematopoietic function in normal horses were studied as a prelude to similar studies in horses infected with equine infectious anemia. These include red blood cell and plasma volumes, $T_{1/2}$ of removal of ^{59}Fe from plasma, $T_{1/2}$ of ^{51}Cr labeled red blood cells, incorporation time of ^{59}Fe in red blood cells. Results appear to correspond favorably with other published values for these parameters in normal horses. (auth)

28540 (NYO-2147-13, pp 103-20) ESTIMATION OF ERYTHROCYTE LOSS IN HOOKWORM INFECTION BY WHOLE-BODY ^{59}Fe COUNTING. Georgi, J. R. (New York State Veterinary Coll., Ithaca. Dept. of Physical Biology).

The volume rate of erythrocyte loss suffered by Ancylostoma caninum-infected dogs was estimated by periodic measurement of whole-body ^{59}Fe retention and erythrocyte ^{59}Fe concentration. Potential sources of systematic bias (normal ^{59}Fe excretion, intestinal ^{59}Fe reabsorption, and variations in whole-body counting efficiency caused by changes in bodily ^{59}Fe distribution) were studied experimentally. The first two sources tended to balance each other; the third was ordinarily insignificant and always amenable to correction. Objection is raised to the custom of expressing observations on the movement of erythrocyte labels as blood loss and the appropriateness of various commonly applied blank corrections is challenged. In harmony with the observations of others, the peak erythrocyte loss was found to precede the onset of egg production. The advantages of ^{59}Fe over ^{51}Cr as an erythrocyte label and of whole-body counting over fecal assay as a measurement technique are discussed. (auth)

28541 (ORNL-4100, pp 152) CHEMICAL PROTECTION AND ENZYME CATALYSIS. (Oak Ridge National Lab., Tenn.).

COENZYMES—role of glutathione and optical isomers of glutathione as, in glyoxalase system

X RADIATION—effects on mice, protective effects of glutathione and sulfhydryl-containing peptides against (H.L.W.)

28542 POST-IRRADIATION OXYGEN SENSITIVITY OF BARLEY SEEDS VARYING SLIGHTLY IN WATER CONTENT. Conger, B. V.; Nilan, R. A.; Konzak, C. F. (Washington State Univ., Pullman). Contract AT(45-1)-353. Radiat. Bot., 8: 31-6(Feb. 1968). (RLO-353-14).

Himalaya barley seeds ranging in water content from 9 to 12 percent, and differing individually by only 0.2–0.3 percent, were irradiated in a vacuum with 25 krad of ^{60}Co γ rays. After irradiation they were immediately (within 1 min) hydrated in either oxygen- or nitrogen-bubbled water at 0°C for a period of 16 hr. Results, as reported in terms of seedling injury, indicated that there is a very critical region in which a small change in water content greatly alters the oxygen-dependent damage. In a region of only 0.3 percent water content change, i.e., between 10.7 and 11.0 percent, the response to oxygen dropped by a factor of more than 2.5. The oxygen-independent damage was not influenced by a change in seed water content in the 9–12 percent region. Based on the hypothesis that oxygen and radiation-induced free radicals interact to produce at least a part of the biological damage, it would appear that mobility, and hence interactions, of oxygen-reactive radicals have rather specific water requirements. (auth) (UK)

28543 PROCESSING OF GAMMA SPECTRA OF THE COUNTER FOR MEASURING TOTAL RADIOACTIVITY IN MAN. Sereda, M. G. (Inst. of Medical Radiology, Erevan). Med. Radiol., 13: 42-6(Jan. 1968). (In Russian).

A procedure is suggested for application of the matrix method in processing γ spectra to the human body radiation spectra, i.e., to extended sources in presence of an absorber. An analysis was performed of possible sources of background pulses in measuring natural radioactivity, as well as in a case when a radioactive label was incorporated for diagnostic purposes. The finding was that the special method for direct matrixing of transition makes preliminary cancellation of the background unnecessary. A pattern matrix is shown for processing spectra of isotopes ^{131}I, ^{58}Co, and ^{59}Fe, administered in combination. (auth)

28544 POSITION OF PICKUPS OF A MULTIDETECTOR COUNTER IN MEASURING TOTAL RADIOACTIVITY IN MAN. Gabuniya, R. I.; Sereda, M. G. (Inst. of Medical Radiology, Erevan). Med. Radiol., 13: 38-42(Jan. 1968). (In Russian).

A four-detector scintillation counter [with crystal NaI (Tl)] was used to measure radioactivity of the whole human body. It was stated that detectors and the subject under measurement must be so placed as to exclude the influence of position of emanating sources (incorporated in the subject's body at selected points) upon the counting rate. A quotient solution of an equation is given for a uniform counting rate ($\Sigma_{i=1}^{n} 1/R_i^2 = \text{const}$) in a case when the subject is positioned along the straight line running between the pickups. A method is suggested for reducing the variance of results obtained in investigating metabolism of radioisotopes (exemplified by ^{131}I) incorporated into the patient's body. (auth)

28545 RADIUM THERAPY OF HEMANGIOPERICYTOMA. Pereslegin, I. A.; Galil-Ogly, G. A.; Poroshin, K. K.; Purizhanskii, I. I. (Central Scientific-Research Inst. of Roentgen-Radiology, Moscow). Med. Radiol., 13: 15-18(Jan. 1968). (In Russian).

Data are given of the results of radium therapy of seven patients suffering from hemangiopericytoma. A female patient with malignant hemangiopericytoma of the lung was successfully treated by combining x-ray surgery with chemotherapy and a long-term remission was attained. (auth)

28546 THE USE OF RADIOACTIVE ^{32}P IN THE DIAGNOSIS OF TESTICULAR TUMORS. Miao, Ting-chieh; Chao, Hui-yang; Hsiung, Ju-cheng. Chung Hua I Hsueh Tsa Chih, 49: 496-8 (Aug. 1963). (In Chinese).

Early detection and differential diagnosis of testicular tumors remains a difficult problem. The use of ^{32}P in 24 patients suspected of testicular tumor is reported. The method is based on: the greater uptake of phosphorus by the neoplastic as compared with normal tissue; the testicle of the unaffected side can be used as control; proximity of the testes to the scrotal wall permits accurate measurement of radioactivity. Of the seven patients with a positive radioactive test, five were confirmed by biopsy to have malignant tumor while two had only inflammation of the scrotum. Of the 17 patients showing negative results, all but one had proven non-neoplastic lesions. (JPRS)

28547 REDEFINITION OF POINT "B" IN THE TREATMENT OF CANCER CERVIX BY RADIOTHERAPY. Kapoor, H. K.; Sahai, I.; Bhardwaj, O. P. (Maulana Azad Medical Coll., New Delhi). Indian J. Radiol., 20: 205-7(Nov. 1966).

The arrangement of internal radiation sources and corresponding dosimetry in uterine cancer were reexamined from the viewpoint of delivering a maximum dose to the tumor while preventing injury to healthy tissue. In treatment of cancer of the cervix by intracavitary Ra or ^{60}Co, the doses were calculated on the basis of two hypothetically representative points, A and B. The point A was of importance as it was believed to be a good index of normal tissue tolerance as well as of dose to the tumor, and comparable from case to case. Dose calculations at the point A and B were in error if these points were not properly located. In a normal, centrally placed uterus the points A and B were quite consistent with the original definition and the doses at each of the two points A in left and right paracervical triangles were equal. Numerous distortions caused by bulky neoplastic masses, ulceration, infection, or tissue breakdown, caused the uterus to be pulled to one side or angulated laterally in left or right direction. Therefore, the distribution of Ra sources in the uterus varied considerably from what was theoretically assumed. With a shift of the uterus, the point A moved accordingly. In 1962, Scheer redefined the point A. The point B, a fixed point, was defined to permit irradiation of the obturator nodes, a common site of metastasis. Point B was defined as 3 cm lateral to point A. Points A and B should be redefined, independent of each other, keeping in view that point B, a fixed point, does not change with the shift of the uterus while the point A moves with the uterus. Scheer's definition of point A should be accepted and point B should be redefined. Irrespective of the position of the uterus and Ra tubes in the uterine canal, point A was 2 cm vertically above the lower end of the lowest uterine tube in the midline and 5 cm perpendicular to it. With the shift of the uterus, normally the fundus and the body of the uterus moved while the external os of the cervix shifted only slightly; therefore the distal end of the distal Ra tube could be taken as the point from which the calculations should be made. The dose at both the right and left points B should be calculated separately before planning external irradiation. (TSS) (BBB)

28548 ROLE OF CHAIN-RADICALS PROCESSES' INHIBITION IN CHEMICAL PROPHYLAXIS OF RADIATION INJURIES. Mozzhukhin, A. S.; Antipenko, E. N.; Mikhailova, E. G. Tr.

Mosk. Obshchest. Isptyt. Prir., Otd. Biol., 16: 95-8(1966). (In Russian).

From Symposium on Free Radicals Processes in Biological Systems, Moscow. See CONF-640635.

The protective action of six screened phenols within the peritoneum 5 to 15 min after irradiation was studied in experiments on white mice irradiated with filtered 400, 550 and 700 R x rays. The reagents introduced interventrally were inoculated in peach oil. In a number of experimental series cystamine was introduced before and screened phenols after irradiation with radiation doses of 400 and 550 R. No protective action of the screened phenols different from that of the oil was registered. Statistically reliable mutual intensification of the radioprotective action of cystamine introduced before irradiation and ionol introduced after, was observed when mice were irradiated with 700 R doses. (auth)

28549 USE OF SOME CHEMICAL AGENTS FOR PROTECTING THE SKIN RADIUM THERAPY OF MALIGNANT NEOPLASMS. Kazhlaeva, U. I.; Isaev, M. S. (Scientific-Research Inst. of Roentgenology, Radiology, and Oncology, Baku). Med. Radiol., 13: 8-11(Jan. 1968). (In Russian).

When malignant neoplasms are irradiated the skin integument is liable to be injured and in a number of cases the planned course of radium therapy has to be discontinued. Recourse is made to various methods helpful in reducing the skin reaction during irradiation, including the use of chemical agents. In the course of radium therapy of 154 patients the authors checked a possibility of protecting the skin by means of topical application of the following chemical agents: "growth substance" derived from crude oil (0.05% and 0.5% solutions), mercamine, procaine, sodium gallate, 96% alcohol and kinetosine. Clinical trials demonstrated that mercamine, procaine, 96% alcohol and kinetosine provide local radiation protection to a fairly high degree and may be recommended for practical use to enhance tolerance of the skin when malignant tumors are irradiated. (auth)

28550 RADIOMETRY OF THE ENTIRE BODY IN INVESTIGATIONS OF IODINE METABOLISM. Lyass, F. M.; Kalantarov, K. D.; Palinkashi, D. G.; Varentsov, Yu. M. (All-Union Scientific-Research Inst. of Medical Instruments and Devices, Erevan). Med. Radiol., 13: 33-7(Jan. 1968). (In Russian).

An original method was suggested for investigating iodine metabolism by means of radiometry of the whole body, the method enabling dynamic representation of the pattern of the main stages in iodine metabolism, i.e., iodine uptake in the thyroid tissue, excretion of iodine from the organism and organic iodine metabolism in the tissue. Investigation of iodine metabolism in 116 patients with cerebral tumors yielded evidence that a change in metabolism of iodine may take place not only according to the pattern when all indices are concurrently increasing or decreasing, but also according to a pattern when a change is observed but in one stage of iodine metabolism, while indices of other stages remain normal. Thus the method suggested permits assessment of the specific function of the thyroid in the iodine metabolism system. (auth)

28551 SIGNIFICANCE OF ROENTGENOLOGICAL FINDINGS IN THE EVALUATION OF MATURITY OF THE NEWBORN. Kalra, K.; Haldar, P. K.; Kishore, N.; Dayal, R. S. (Medical Coll., Agra, India). Indian Pediat., 3: 224-30(1966).

Four hundred eighty-six newborns were studied roentgenologically for the presence of certain ossification centres. Correlation of these findings with the birth wt was tried. The occurrence of ossification centres for calcaneum, talus, distal epiphysis of femur, proximal epiphysis of tibia, cuboid and navicular were studied on the standard radiographs of knee and ankle joints. It was observed that as the birth wt increases, there is a gradual increase in the percentage of occurrence of these ossification centres. The ossification centres are more frequently seen in females as compared to males in all comparable wt groups. The presence of any particular centre can not be taken as a reliable index of maturity and vice versa. Hence, roentgenological studies are only of academic nature and best be avoided because of the risk and consequences of irradiation. 23 ref. (Indian Sci. Abstr.)

28552 THE PROTECTIVE EFFECTS OF SOME NARCOTIC SUBSTANCES AGAINST X IRRADIATION ON AQUATIC ANIMALS. 3. EFFECTS OF URETHANE AND CHANGES IN CONCENTRATION OF CHLOROBUTANOL SOLUTION AGAINST X IRRADIATION IN LARVAE OF RHACOPHORUS ARBOREUS. Tanaka, Norimoto (Kyoto Prefecture Univ.). Nippon Igaku Hoshasen Gakkai Zasshi, 26: No. 8, 1016-21(Nov. 1966). (In English).

The highest degree of radioprotection, in term 27 days survival, and a little radioprotection in the body weight growth were observed in Rhacophoru tadpoles that were soaked in 1% urethane 5 min prior to and during (6 minute) x-irradiation. Radioprotection of survival was observed in Rhacophorus tadpoles that were soaked in 2 and 5% chlorobutanol solutions, but was not observed with 1% chlorobutanol. The radioprotective effect on the development growth of body weight with the above mentioned narcotic substances (2 and 5% concentration) was observed to be slight. It is concluded that the mechanism of the radioprotection of the various narcotic substances used in the present experiments is probably caused by the changes of the oxygen content of the cells and considerably reduced oxygen consumption. However, other biological factors, for example the nervous system, must not be overlooked and moreover, the chemical properties of these narcotics may be related causes. (NSA of Japan)

28553 SOME ASPECTS OF RADIOTHERAPY OF ABDOMINAL TUMO[illegible] Salzman, Ferdinand A.; Smedal, Magnus I. (Lahey Clinic Foundation, Boston). Surg. Clin. N. Amer., 47: 679-84 (June 1967).

Radiobiological basis of irradiation of abdominal tumors, including radiosensitivity of different types of tumors, the oxygen effect, injury and sequelae, and protection, are reviewed. Fully oxygenated cells are about 2.3 times more sensitive than anoxic cells to the same dose of irradiation, and the dose necessary to sterilize a tumor increases with the number of cells in the tumor. Bleeding, friable, and exophytic tumors generally are more radiosensitive than infiltrating, infected, and ulcerated tumors of the same histologic type. This is explained by the differences in vascularization of the regional tissues, particularly the microcirculation of the tumor, that affects the degree of oxygenation of the tumor. The total volume of abdominal tissues requiring irradiation governs the accumulating daily fractional doses of irradiation that can be tolerated by the patient in terms of anorexia, nausea, diarrhea, and leukopenia. The most sensitive normal intra-abdominal structure is the kidney; total irradiation doses of 2300 R to the whole of both kidneys over five weeks or less may induce radiation nephritis. Manifestations of small intestine irradiation intolerance occur at doses under 2000 R, but no serious sequelae are expected until total doses exceed 4500 R. Many patients were irradiated to higher doses without serious sequelae; on the other hand, previous pathologic processes involving the small intestine, such as infections, adhesions, and involvement by tumor, contribute to the development of ulceration and necrosis, with resultant perforation and fistula formation at doses close to 4500 R. Radiation damage to the liver has seldom been reported; this is probably because the primary disease proved fatal shortly after high irradiation doses to this organ. No serious difficulties occur until doses exceed 4000 R. Gastrointestinal irradiation commonly results in varying combinations and degrees of severity of anorexia, nausea, diarrhea, and decline in the leukocyte count. The prevention and treatment of these are described. (BBB)

28554 POSTIRRADIATION VASCULAR INSUFFICIENCY SYNDROME: CASE REPORT. Darmody, W. R.; Thomas, L. M.; Gurdjian, E. S. (Wayne State Univ., Detroit). Neurology, 17: 1190-2(Dec. 1967).

Radioinduced vascular injury in the brain was described. The clinical picture was that of progressive stenosis, then occlusion of the middle cerebral artery, three yr after a second course of irradiation for pituitary tumor. The 20-yr-old woman began x ray therapy in December, 1958 and received a total of 7000 R through three portals (5- by 5-cm field size) utilizing standard 250-KV equipment in 32 days. The patient received a second course of ^{60}Co γ ray therapy in December, 1962, a total dose of 3500 R over 28 days being given to a 4- by 5-cm field size through two portals. In November, 1965, she complained of left-sided weakness, and experienced transient episodes of left hemiparesis. Carotid arteriograms suggested a right middle cerebral artery stenosis with peculiar narrowing of the proximal vessels on angiography. Craniotomy was performed, confirming the absence of a pituitary tumor, and biopsies of branches of the middle cerebral artery were taken. Histologically, the specimens exhibited thickening and fibrosis of the vessel wall with marked endothelial proliferation, fitting the description of vascular changes secondary to radiation. The clinical picture evidently was the result of middle cerebral artery occlusion. The amount of irradiation exceeded the commonly accepted safe levels. (BBB)

28555 STUDIES ON CHANGES INDUCED BY INTERNAL IRRADIATION ON FATTY ACID COMPOSITION OF ORGANS AND SERUM. PART III. CHANGES OF LONG-CHAIN FATTY ACID COMPOSITION INDUCED BY IRRADIATION IN THE SERUM OF PATIENTS WITH BREAST CANCER. Katsumata, Naomi (Okayama Univ., Japan). Okayama Igakkai Zasshi, 79: 181-7 (Apr. 1967). (In Japanese).

The changes in long-chain fatty acid composition of the serum of breast cancer patients after radiation therapy were studied.

Total fatty acids in the serum of the patients, both before and after radiation treatment, were separated and identified by gas-liquid chromatography. The total fatty acid composition in the serum at the time when the tumor became smaller approached the level of normal persons, in contrast to the level before radiation therapy. It was considered that radiation therapy was a success when the polyunsaturated fatty acids, especially linoleic and arachidonic acids, were increased and saturated fatty acids decreased. (BBB)

28556 THE IMPORTANCE OF RADIOTHERAPY WITH SMALL DOSES. Scherer, E. (Roentgeninstitut der Staedtischen Krankenanstalten, Essen). Roentgen Bl., 18: 400-6(Sept. 1965). (In German).

Too frequently the treatment of benign diseases with small doses of x irradiation is overlooked. Provided that suitable protection is afforded, the exposure of the gonads during irradiation for neuritis, inflammatory processes, and other diseases can be minimized. Reports indicate that if in early childhood the thymus is irradiated with x ray doses between 300 and 500 R, the incidence of leukemia may be increased. In infants, even though a single dose of 10 R to the thorax may give a dose of 0.03 R to the testes or a dose of 0.13 R to the ovaries, it may be necessary in extremely serious cases of interstitial pneumonia. In 155 patients suffering from rheumatoid arthritis of the spine, that were irradiated in 1962 with 600 R, not a single case of leukemia was reported so far. In these cases where 100 R per treatment was given, the scattered irradiation to the gonads may have ranged from 30 to 80 mR, depending on the direction of the beam and the field size. If the gonadal beam is directed upwards and the patient is shielded with Pb, the gonadal dose may be reduced. (BBB)

28557 TREATMENT OF BASAL CELL CARCINOMA BY PLASTIC SURGERY. Sundell, Borje; Gylling, Uno; Solvio, Atso I. (Finnish Red Cross Hospital for Plastic Surgery, Helsinki). Acta Chir. Scand., 131: 249-53(Mar. 1966).

Of 66 patients receiving radiotherapy for basal cell carcinoma, 18 incurred radiation injury that required plastic surgery. Techniques used for and results of such surgical repair are reported. The remaining tumor and radioinjured skin were excised radically under local or general anesthesia. A margin of 5 to 10 mm, at least, of clinically normal tissue was removed. If possible, the excision included all radioatropic tissue because it was considered potentially malignant. Two patients with multicentric facial lesions had postoperative radiation therapy. Most small lesions were effectively treated by excision and the defect was repaired by direct suture. In 10 patients skin defects were repaired with a full-thickness or thick split-thickness skin graft. The defect was localized in six instances to the nose where direct suture closure would be difficult to achieve. The skin graft was taken from the postauricular region. Tumors localized to the upper and lower eyelids and the inner canthus and the nose constituted a special problem because of greater likelihood of radiation damage and difficult surgical excision and repair in these regions. A transposition flap repair was used in these patients. A direct closure of skin defects in the upper and lower lids and the nose could produce distortion and deformity. The long-term cosmetic and functional result of the operative treatments was satisfactory. (BBB)

28558 CYTOGENETICS STUDIES IN ATOMIC BOMB SURVIVORS. Iseki, Tetsuya (Nagasaki Univ.). Nippon Naika Gakkai Zasshi, 55: 76-83(May 10, 1966). (In Japanese).

The effects of atomic bomb radiation on leukocyte chromosomes were studied. Seven male and 15 female atomic bomb survivors, 20 to 69 years of age, in Nagasaki and Hiroshima were examined. Blood cell chromosome analysis was conducted with Moorehead's white cell cultural and staining methods to determine the chromosome number and frequency of chromosome aberrations. The chromosome abnormalities of atomic bomb survivors included high incidences of aneuploid cells (7.9 to 10.9%), polyploid cells (0.15 to 0.25%), and fragments (0.5 to 3.0%). Qualitative chromosome aberrations in the form of dicentrics, rings, and abnormal monocentric chromosomes were also demonstrated in these atomic bomb survivors, while these aberrations were not observed in normal controls. Among the atomic bomb survivors, the high frequency of abnormal chromosomes was observed in those patients who had developed acute radiation symptoms at the time of exposure. The incidence of leukemia in the survivors increased rapidly after 1947, reached a maximum in 1951 to 1955, and gradually decreased thereafter. There was a correlation between the incidence rate and the distance of exposed subject from the hypocenter. The incidence of chronic myeloid leukemia was particularly high in survivors of the atomic explosions. (BBB)

28559 ENZYMIC PROCESSES IN VASCULAR PERMEABILITY AND FRAGILITY CHANGES IN THE SKIN RADIATION REACTION. Jolles, B.; Harrison, R. G. (General Hospital, Northampton, Eng.). Bibl. Anat., No. 9, 482-7(1967).

Vascular permeability and capillary fragility were measured in rabbits and guinea pigs after whole-body x irradiation with a dose of 350 R to 400 R to the right and left sides of the animal at 230 KV. Local skin irradiation was carried out at 100 KV. A dose of 1000 R through a 5-cm dia applicator was given to one of the rabbit flanks clipped 24 hr previously to avoid skin irritation. In guinea pigs the dose required for a skin response was 4000 R at 50 KV over an area 2.9 cm in diameter. Blood pressure changes following irradiation did not contribute to the changes in vascular permeability. The maximum degree of radiation reaction was obtained when local and distant factors essential for tissue response with which the body and each skin unit are endowed were not affected, or when an adequate time for their restoration had elapsed, or when as in the case of sieve or grid x-ray therapy sufficient unirradiated tissue remained to act as an anchor for the inflammatory reaction. The absence of attenuation of the permeability with antihistamines or 5-hydroxytryptamine antagonists played minor roles. The response was very much reduced or altogether abolished by compounds that inhibit proteolytic enzymes. Vasoactive compounds, such as Hexopal and trihydroxyethylrutoside, reduced the number of petechiae that appeared after irradiation. (BBB)

28560 RADIOISOTOPE (GAMMA) CEREBRAL ANGIOGRAPHY: TECHNICAL NOTE. Owens, Guy; Bender, Merrill, A.; Blau, Monte (Roswell Park Memorial Inst., Buffalo). J. Neurosurg., 27: 466-70(Nov. 1967).

Scintillation cameras visualize the entire nuclide distribution at one time. Very short-lived nuclides improve picture quality while maintaining a low radiation dose. Short exposure time and continuous sensitivity permit rapid sequences of still pictures or time lapse motion pictures of subjects in which the distribution of radioactivity is changing. The development of the autofluoroscope and the use of short-lived isotopes now make it possible to evaluate the cerebral arterial, capillary, and venous phases of circulation separately as well as to locate neoplasia and areas of vascular insufficiency or abnormality. Use of the digital autofluoroscope in ^{137m}Ba cerebral angiography is reported for 9 cases in which the tumor was well localized by this technique. (BBB)

28561 PROTECTIVE AND THERAPEUTIC EFFECT OF MARINAMYCIN AGAINST LEUKOPENIA IN X-IRRADIATED RABBITS. Soeda, Momoe (Japan Defense Agency, Tokyo). Nippon Igaku Hoshasen Gakkai Zasshi, 22: 199-203(June 25, 1962). (In Japanese).

To test the protective effect of marinomycin, rabbits were injected intravenously once a week for three weeks and then exposed to two 182-R doses of x rays at an interval of 16 days. Leukocyte levels were followed twice weekly for 80 weeks. In the control irradiated rabbits, 73 days were required for the leukocyte count to return to normal after irradiation, compared with only 10 days in the marinomycin-injected animals. In addition to testing its prophylactic effect, the therapeutic action was examined by injecting 10 mg of it into rabbits two to five days after exposure to x-ray doses of 182 or 300 R. The results showed that it required only one-third as long for leukocyte counts to return to normal when marinomycin was administered after irradiation. (BBB)

28562 COMPARISON OF RESULTS OF BRAIN SCANNING WITH ^{99m}Tc PERTECHNETATE AND ^{197}Hg CHLORMERODRIN. Stanbro, William W.; Murphy, Cornelius F. (George Washington Univ., Washington, D. C.). Med. Ann. D. C., 36: 733-5(Dec. 1967).

When used for brain scanning, ^{99m}Tc-pertechnetate had several advantages over ^{197}Hg-chlormerodrin, the most important of which was a higher count rate for a lower radiation dose. However, the radiation dose from ^{197}Hg-chlormerodrin was within an acceptable range, and by using a low-energy collimator the count rate was increased, with resulting improvement in the statistics. Choice between the two depended primarily upon their relative performance as judged by the diagnostic accuracy of their scans. A comparative study was made of ^{99m}Tc-pertechnetate and ^{197}Hg-chlormerodrin brain scans obtained by scanning 60 patients with both isotopes. The dose of ^{99m}Tc used was 5 mCi, which when injected intravenously resulted in a maximum of 40,000 to 60,000 cpm. The dose of ^{197}Hg was 15 μCi/Kg, not exceeding a total dose of 1 mCi, which when injected intravenously resulted in a maximum of 2000 to 4000 cpm. In seven patients, positive ^{197}Hg and negative ^{99m}Tc scans were obtained and in three patients the ^{197}Hg scans were superior to the ^{99m}Tc scans. Two of the seven patients with positive ^{197}Hg and negative ^{99m}Tc scans could represent false positives in that subsequent arteriograms were negative. The

^{99m}Tc scans consistently demonstrated normal vascular structures better than the ^{197}Hg scans. Comparison of results in 60 patients with both isotopes suggested that ^{197}Hg-chlormerodrin could prove to be superior to ^{99m}Tc-pertechnetate from the standpoint of diagnostic accuracy. (BBB)

28563 RADIATION INJURY OF THE URINARY BLADDER AFTER RADIUM TREATMENT OF PORTIO CARCINOMA. Vizkelety, J. (Univ., Budapest). Z. Urol. Nephrol., 60: 433-5 (June 1967). In German).

Several degrees of radiation injuries of the urinary bladder are described. As long as the bladder wall was not necrotized or fistulated only pain-suppressant drugs were administered. Hyperemia was the mildest form of bladder radiation injury. This was followed by fibrin formation, bullous edema, hemorrhages, tissue breakdown, and finally ulceration. Sometimes the edema was so severe that it resembled a tumor when viewed cystoscopically. In later stages the irradiation affected not only the mucosa, but also the deeper layers of the bladder wall. This led to formation of fistulas, and incrustation of the necrotic tissues from infection. The hemorrhages were slight, but could be so severe that blood transfusions were required. The hemorrhages began several months to one or two yrs after irradiation and could not always be controlled by electrocoagulation. The later infections that occurred were usually of mixed types and caused deposition of Ca and Mg phosphate salts. These required curettage, along with broad-spectrum antibiotic therapy. Vaginal or rectal fistulas were very difficult to treat. Severe skin eczemas appeared. Construction of an anus praeternaturalis should be considered in the light of the patient's condition. (BBB)

28564 A SYSTEM FOR THE MEDICAL EXAMINATION OF MASS CASUALTIES. Ross, W. M. J. Roy. Army Med. Corps., 113: 40-6(1967).

A priority system of handling mass casualties, including those that might be expected after thermonuclear explosions in populated areas, is presented. This priority system is outlined as follows: Priority 1(a): Those requiring minimal treatment (small lacerations or contusions; simple fractures of small bones; second degree burns, less than 10%; acute whole-body radiation <150 rad). Priority 1(b): As 1(a) but who may require some degree of untrained help (e.g. disabling minor fractures; burns of face or hands making self-help difficult; minor neuropsychiatric disorders; early symptoms of acute radiation damage). Priority 2: Those requiring immediate care (hemorrhage from accessible site; rapidly correctable mechanical respiratory defects; severe crush injuries of extremities; incomplete amputations; severe laceration with fracture of long bones; severe burns of face). Priority 3: Those whose surgical treatment may be delayed (simple fracture of major bones; moderate lacerations without severe bleeding; second degree burns of 10 to 20% body surface; third degree burns of 10 to 30% body surface; noncritical CNS injuries). Priority 4: Those whose therapy may be delayed but not neglected (critical injuries of CNS or respiratory system; penetrating or perforating abdominal injuries; multiple severe injuries; severe burns of large areas (>40%); established lethal or supralethal doses of radiation). Thus, the most serious cases, those whom in normal casualty work are given first priority, may under mass casualty situations rate a low priority because of the surgical man-hours and the facilities which each one requires for successful treatment and which would detract from the treatment of other casualties. (BBB)

28565 RADIOACTIVITY IN THE INDIVIDUAL: EFFECTS OF IONIZING RADIATION FROM THE ATOMIC BOMB ON JAPANESE CHILDREN. Miller, Robert W. (National Cancer Inst., Bethesda, Md.). Pediatrics, 41: Suppl., 257-70(Jan. 1968).

The Atomic Bomb Casualty Commission's (ABCC) study of the delayed effects of ionizing radiation on children that may have been induced before conception, during intrauterine life, or during childhood is summarized. Results thus far indicate that genetic effects were not great enough to be revealed under the conditions of the investigation. Microcephaly was found in 13 children exposed in utero to the atomic bombs in Hiroshima. They were born of mothers who last menstruated 7 to 15 weeks before the bomb. The frequency of microcephaly diminished as the distance from the hypocenter increased. Among women who were within 2000 m of the hypocenter, the rate of fetal or infant loss was much higher if the mother had one or more major signs of acute radiation injury than if she had none (43.3% vs 8.8%), the difference being statistically significant at the 0.1% level. Twenty cases of leukemia developed among children within 1500 m of the hypocenter who were exposed before their tenth birthday. The only cancer other than leukemia that occurred in excess of normal expectation among those exposed to the atomic bomb was thyroid carcinoma. Radiation cataracts occurred in a few adults exposed to the atomic bombs but were not observed in children. It was concluded that the total number of delayed organic effects of atomic irradiation among Japanese children was small. The most prevalent late effect, difficult to document, was the fear of late effects. (BBB)

28566 REGENERATION OF BONE MARROW CELLS AND THYMUS INDUCED BY 19S ALPHA-2 GLOBULIN IN IRRADIATED MICE. Berenblum, I.; Burger, M.; Knyszynski, A. (Weizmann Inst. of Science, Rehovoth, Israel). Nature (London), 217: 857-8(Mar. 2, 1968).

The 19S alpha-2 globulin isolated from the alpha-2 globulin fraction of human serum was found to stimulate the regeneration of bone marrow cells in X-irradiated mice. A sample injected intraperitoneally into mice within an hour of exposure to 170R produced a significant speeding up in the incorporation of ^{3}H-thymidine into bone marrow cells. Seven days after irradiation the injected animals actually showed an overshoot in number of cells of femoral and tibial bone marrow as compared with unirradiated controls and irradiated saline injected controls. The total DNA content of bone marrow cells showed a similar picture. With four irradiations (170R per week) the regeneration effect was enhanced compared with the single irradiation. There was also a stimulating effect on regeneration of the thymus. In mice exposed to 170R once a week for 4 weeks, injection of the globulin after each exposure produced, 3 weeks after the last injection, a significant increase in thymus weight. In all cases other fractions isolated from the alpha-2 globulins of human serum had less or no effect. Some studies were also made with extracts of sheep spleen; only extracts containing 19S alpha-2 globulin had a stimulating effect on the regeneration of thymus in irradiated mice, and on bone marrow regeneration. The effect of this globulin on radiation leukaemogenesis in mice is also being investigated; preliminary results indicate an inhibitory effect. (UK)

28567 LESION GENERATOR FOR CONTROLLED RADIO-FREQUENCY LESIONS IN STEREOTAXIC SURGERY. Smith, B. H.; Seymour, B. (Univ. of Adelaide). Med. Biol. Eng., 5: 571-8(Nov. 1967).

Lesions produced in the brain of dogs by rf energy were described after a discussion of the requirements for the creation of controlled lesions in brain tissue. A suitable instrument using the rf heating method was described. The instrument had monitoring facilities making it suitable for research, and incorporated protection circuits that made it safe under extreme conditions of misuse. About 90 lesions were made in dogs' brains with varying parameters of temperature, duration, and probe tip length. The dogs were sacrificed at varying times after the operation to obtain a representative series of lesions, ranging from one hr to 30 days posttreatment. The lesions were all sharply circumscribed, ovoid in shape and relatively bloodless. Bleeding was confined to the immediate vicinity of blood vessels within the lesion area. After 30 days, the lesion consisted of an oval, well-defined avascular area. The equipment was also used in 15 human stereotaxic operations for Parkinson's disease and other movement disorders. The absence of undesirable side-effects, such as somnalence and confusion, frequently seen with earlier, uncontrolled forms of lesion induction (e.g., with surgical diathermy) permitted development of multiple lesions through the target area with confidence, thus obtaining the optimal physiologic effect. (BBB)

28568 RADIONECROSIS OF THE RIBS IN A PATIENT WITH MAMMARY CARCINOMA. Ishikawa, Kosuke; Nozaki, Yoshio (Tottori Univ., Japan). Yonago Acta Med., 11: 10-14(Feb. 1967). (In German).

Two yr following treatment for mammary carcinoma with 200 R at one or two-day intervals, and totaling 4800 R supraclavicular, 4000 R parasternal, 3800 R anterior chest wall, and 3800 R axillary x irradiation, spontaneous fracture of the left, fourth rib was observed. The fracture was not accompanied by carcinogenesis, and no metastases were observed. Some callus formation was detectable within three months after discovery of the fracture. The perpendicular irradiation of the left axilla and the tangential irradiation of the left anterior chest wall, which had extended over a relatively short period of 45 days gave a focal dose of 5200 R to the fracture site. The latent time between irradiation and appearance of the lesion was extended, as compared to the periods reported by other authors. The authors suggest that greater use of tangential irradiation could reduce possibilities of complications of this type. (BBB)

28569 CYSTOMANOMETRIC STUDIES FOLLOWING SURGICAL AND RADIOTHERAPEUTIC TREATMENT OF GYNECOLOGIC TUMORS. Beckmann, K. H. (Frauenklinik des Staedtischen Krankenhauses im Friedrichshain, Berlin). Zentralbl. Gynaekol., 87: 1693-702(Dec. 4, 1965). (In German).

Of 38 patients with uterine carcinoma who were irradiated with 1000-mg-hr doses of Ra, 29 showed an average reduced bladder capacity of about 80 ml that persisted for about 1/2 yr after irradiation before returning to preirradiation values. In more than 1/3 of all cases bladder pressure deviated from normal. In these cases normal values were restored after 1/2 yr. Micturition pressure decreased markedly in 33 of the irradiation patients. After 1/2 yr, the pressure was still reduced by about 20 mm Hg in eight of these patients. Treatment by vaginal surgery with postirradiation resulted in more reduction of bladder capacity, but comparatively less effect on bladder and micturition pressures. When combined x irradiation and Ra treatment was administered for uterine carcinoma, the sum of the irradiation effects tended to extend the time required for the bladder capacity and the bladder and micturition pressures to return to normal values, as compared to surgical treatment or to a combination of surgery and x irradiation. (BBB)

28570 PECULIARITIES OF THE PERMEABILITY OF VASCULAR-TISSUE BARRIERS OF RABBIT INTERNAL ORGANS IN ACUTE RADIATION DISEASE COMBINED WITH BLEEDING. Karchevskii, A. F. (Medical Inst., Kharkov). Vop. Eksp. Klin. Radiol., Kharkov. Inst. Med. Radiol., No. 1, 36-45(1965). (In Russian).

Rabbits were bled following a 1400 R dose of γ radiation. The blood loss (25%) was replaced by an equal volume of polyglucan. Phosphorus-32-labeled Na_2HPO_4 was used to determine permeability of vessel-tissue barriers. Permeability was increased in all blood vessels and in some organs during the first three days. Phosphorus-32 was lost from some organs as radiation sickness developed, possibly due to the loss of blood. Polyglucan was found to be useful in treatment of radiation sickness. (W.E.G.)

28571 EXPERIMENTAL STUDIES ON RADIOPROTECTIVE EFFECT OF GLUTATHIONE AND ITS APPLICATION. Nagata, H. (National Kyoto Hospital); Sugahara, Tsutomu. Nippon Igaku Hoshasen Gakkai Zasshi, 26: No. 8, 975-8(Nov. 1966). (In Japanese).

Radioprotective effects of glutathione were confirmed in mice. The effective dose was 10 mg or 25 mg/mouse fifteen minutes before 700R whole-body irradiation. The increase of survival time of repeatedly irradiated mice (365R of Co γ-ray once per week until the death of animals occurred) was observed with the pretreatment of glutathione at every exposure. The reduction in body weight after ^{32}P injection was restored with glutathione. Protection against internal irradiation was obtained for the first time. (NSA of Japan)

28572 DEVELOPMENT OF ERYTHEMA THRESHOLD VALUES IN PHOTODERMATOSES. Szabo, E.; Horkay, I. (Univ. Medical School, Debrecen, Hungary). Z. Haut- Geschlechtskr., 42: 109-13 (Feb. 15, 1967). (In German).

Comparison of the almost normal erythema dose from 360 mμ uv irradiation in contact dermatoses with the erythema doses of endogenously caused eczemas indicated that the magnitude of the response was related primarily to the quality of the irradiation. In endogenous eczema the rate of heat loss of the skin increased in a cold environment, and the rate of warming of the skin decreased in a warm milieu. Differing reactions were observed after administration of histamine or acetylcholine. The characteristic white dermographism was related to a particularly responsive vascular reaction, indicating the enhanced vasoconstrictive sensitivity of atopic skin. This was supported by the high erythema doses measured by the authors. Antigen-antibody reactions may underlie photoallergies and the common allergic dermatoses. Changes in the mucopolysaccharide, hyaluronidase, and hexosamine composition of skin were observed with several dermatoses. Increased concentrations of vasodilatory substances were noted to accompany some endogenous eczemas and photoallergies. Differences in photosensitivity observed in patients may be related to the wavelength used, and could be used as a means to differentiate between photodermatoses and allergic dermatoses. (BBB)

28573 ROUTINE USE OF RADIOGOLD FOLLOWING OPERATION FOR OVARIAN CANCER. Moore, David W.; Langley, Ivan I. (Emanuel Hospital, Portland, Oreg.). Amer. J. Obstet. Gynecol., 98: 624-30(July 1, 1967).

Complications occurring during and after the treatment of 74 patients with intraperitoneal injections of colloidal ^{198}Au are reported. A dose of 150 mCi of radiogold, diluted with saline and properly distributed throughout the peritoneum, would yield, on the average, 6000 R to the peritoneum and 7000 R to the omentum, assuming an average peritoneal surface at 30,000 cm^2. The colloid was minimally adsorbed by the lymphatics and a negligible amount appeared in the systemic circulation. The injected dose varied from 100 to 200 mCi, with 150 to 175 mCi most frequently being used. No serious complications were encountered in any of the patients treated with intraperitoneal radiogold. Thirty per cent complained of transient nausea within 48 hr of treatment, 20% had transitory elevation of temperature, and 5% had diarrhea which subsided with simple medication. When the patients' excreta were scanned for possible contamination with the radioisotope, to determine whether the bowel wall was penetrated during administration, no contamination was detected. Two patients developed a small indurated tract at the site of injection within a year, which was thought to represent leakage of isotope into the tract of injection, probably due to faulty technique. One patient, now alive and well eight years following treatment, had mechanical bowel obstruction 10 months after radiogold administration. At laparotomy, the ileum was found to be obstructed by a dense adhesive band at the site of previous appendectomy. The abdomen and pelvis were free of adhesions but the peritoneum had a thickened semiopaque appearance, seen in other patients in this series and reported by other authors following the use of intraperitoneal ^{198}Au. Some patients developed many adhesions following the use of radiogold. No loculation of colloidal radiogold with the creation of so-called hot spots with subsequent bowel necrosis, fistulas, and peritonitis, reported by other authors, occurred in this series. (BBB)

28574 CHROMOSOME STUDIES ON JAPANESE EXPOSED TO RADIATION RESULTING FROM NUCLEAR BOMB EXPLOSIONS. Ishihara, Takaaki; Kumatori, Toshiyuki (National Inst. of Radiological Sciences, Chiba, Japan). pp 144-66 of Human Radiation Cytogenetics. Evans, H. J.; Court Brown, W. M.; McLean, A. S. (eds.). New York, John Wiley and Sons, Inc., 1967.

From International Symposium on Human Radiation Cytogenetics, Edinburgh. See CONF-661062.

Survivors of Hiroshima and Nagasaki and fishermen exposed to fallout near Bikini showed chromosome aberrations 19 and 10 to 11 yr after exposure, respectively, that differed quantitatively and qualitatively from those found in the normal population. In the fishermen, two successive examinations at one yr intervals revealed a frequency of aneuploid cells (about 3%) that did not differ significantly from the controls (2.09%). The irradiated individuals had both stable and unstable chromosome aberrations. Of the abnormal cells, 77% contained stable chromosome aberrations and half of these had balanced chromosome constitutions, the remainder had an excess or deficiency of chromatin. Deficient cells usually had 46 centromeres. Deletions were most frequent in group G chromosomes of which more than half resembled the Ph^1 chromosome. (M.M.B.)

28575 LEUKOCYTE CHROMOSOME STUDIES OF ADULT AND IN-UTERO EXPOSED SURVIVORS OF HIROSHIMA AND NAGASAKI. Bloom, Arthur D.; Neriishi, Shotaro; Kamada, Nanao; Iseki, Tetsuya (Atomic Bomb Casualty Commission, Hiroshima and Nagasaki). pp 136-43 of Human Radiation Cytogenetics. Evans, H. J.; Court Brown, W. M.; McLean, A. S. (eds.). New York, John Wiley and Sons, Inc., 1967.

From International Symposium on Human Radiation Cytogenetics, Edinburgh. See CONF-661062.

Exposed survivors who were within 1400 miles of the hypocenters at Hiroshima or Nagasaki when 30 yr of age or less in utero at the time of the bombing were the source of leukocyte cultures. Those with histories of malignant diseases, radiotherapy, diagnostic x rays within the previous 12 months (exclusive of chest x rays), or viral exanthem were excluded from the study. The frequency of dicentrics, rings, fragments, and monocentric translocations was 0.60% in leukocytes of the survivors compared with 0.01% in matched controls. The abnormal cells were found in 35% of the leukocytes from exposed individuals, compared with 1% of the controls. The group in utero (first trimester) at the time of the bombing did not differ statistically, in the frequency of abnormal cells, from the matched controls. (M.M.B.)

28576 RADIOISOTOPE SCANNING OF PANCREAS. Sodee, D. Bruce (Doctors Hospital, Cleveland Heights, Ohio). N. Y. State J. Med., 67: 2325-7(Sept. 1, 1967).

Development of a technique and its clinical use to visualize the pancreas directly through radioisotope scanning are reported. With ^{75}Se–selenomethionine and a large-crystal commercial photoscanner, it was possible to demonstrate the normal pancreas and aid in the detection of pancreatic carcinoma. Following a four to six hr fast, 35 g of glucose were administered intravenously, followed ½ hr later by the intravenous administration of ^{75}Se–selenomethionine, 3.5 μCi/Kg body weight and never less than 200 μCi per patient. The probe (a Picker Magnascanner model 6148P with a 5- by 2-in NaI crystal and an 85-hole broad-focus 5-in resolution depth lead collimator) was manually moved over the abdomen until the highest count rate of the liver was located, between 4000 and 7000 cpm. The pancreatic area, just inferior

to the porta hepatis, was carefully scanned. The normal pancreas, during this period, would have accumulated between 2500 and 3000 cpm of radioactivity. With the described technique the normal pancreas was well visualized in 95% of the patients. The slight angle of the body that was employed positioned the liver away from the pancreatic bed and allowed for visualization of all segments of the pancreas. In 26 of 27 cases of pancreatic carcinoma, the scan was interpreted initially as abnormal. In acute pancreatitis there was almost complete lack of concentration of ^{75}Se–selenomethionine in pancreatic tissue. In patients with proved chronic pancreatitis the scan was not of clinical value, but in some cases there was a decrease in the concentration of ^{75}Se in the pancreas. (BBB)

28577 PLACENTOGRAPHY. Schrieber, Melvyn H.; Red, Donald E. (Univ. of Texas, Galveston). Radiol. Clin. N. Amer., 5: 47-65(Apr. 1967).

Techniques of radioisotope placentrography and the attendant fetal radiation exposures are described. Three isotopes most frequently used in placentography are radioiodinated human serum albumin (RISA–^{131}I), ^{51}Cr-labeled erythrocytes and human serum albumin (HSA), and ^{99}Tc-labeled HSA. The primary disadvantage of RISA is that, despite its relatively stable bond with albumin, a small portion of the ^{131}I disassociates itself and, as the free unbound isotope, crosses the placental barrier. As such, binding by the fetal thyroid with subsequent irradiation to this organ becomes a potential threat. This possibility can be eliminated by the administration of Lugol's solution as a blocking agent 24 hr prior to the examination. Now ^{51}Cr is considered superior to ^{131}I–HSA and is replacing it. The superiority of ^{51}Cr is two-fold. First it is a pure γ emitter (0.32 keV) and as such decreases the radiation exposure to mother and fetus. Secondly, there is essentially no transfer across the placenta, and even if this occurs the isotope is not concentrated in the fetal thyroid. Technetium–^{99m}Tc has superior physical qualities for placentography. Incorporated in HSA, ^{99m}Tc has a short physical half-life (6 hr) and is also a pure γ emitter (140 keV). Little or no placental transfer occurs, and because of its short half-life the radiation exposure to mother and fetus is minimal. The maternal and fetal radiation exposure in isotope placentography is about $^1/_{10}$ that produced by radiographic placentography when two films in the anteroposterior and lateral projections are made. Fetal whole-body exposure was estimated to be 20 mrad using 5 μCi of RISA–^{131}I. By use of ^{51}Cr, exposure to the fetus is lessened because of the isotope's pure γ emission; a 20-μCi dose results in 2 mrad whole-body fetal exposure and 12 mrad maternal whole-body exposure. At doses between 200 and 500 μCi, ^{99m}Tc produces a 5-mrad whole-body fetal exposure. Isotope placentography is a safe and accurate means of placental localization and may be the method of choice. Dot scans, photoscans, and drawings of the maternal abdomen showing the distribution of count rates are less dramatic in appearance than opacified placental sinusoids seen with arterial placentography, but because of the much lower radiation dose to mother and fetus and because of the high accuracy, isotope placentography is as acceptable as other methods. (BBB)

28578 EXTRACORPOREAL IRRADIATION OF BLOOD (ECIB) IN MAN. II. TREATMENT OF ACUTE MYELOCYTIC LEUKEMIA. Schiffer, L. M.; Atkins, H. L.; Chanana, A. D.; Cronkite, E. P.; Greenberg, M. L.; Stryckmans, P. A. (Brookhaven National Lab., Upton, N. Y.). Blood, 31: 17-32(Jan. 1968).

Fourteen adults with acute myelocytic leukemia (AML) received 16 courses of extracorporeal irradiation of the blood (ECIB). The median survival time of 8.0 months, taking into consideration many of the variable factors, was as good as, if not better than, studies previously reported despite the absence of hematologic remissions. This group of patients is small, however, and no definitive evaluation of ECIB treatment for AML can be made. Although no significant bone marrow changes were noted, there was a marked decrease in the peripheral leukemic cells of 75 per cent of the patients. There appears to be a correlation of increased survival time with a transit dose of ECIB over 340 rads. At the present time, the usefulness of this mode of treatment in the overall management of AML is uncertain, although it might be considered as an alternative form of therapy for patients in whom chemotherapy is contra-indicated and to prevent leukostatis. When used, the possibility of complications related to the shunt should always be borne in mind. (auth)

28579 ANTIRADIATION COMPOUNDS. IX. DITHIOCARBAMATES OF STRONGLY BASIC PYRIDINES AND PYRIMIDINES. Foye, William O.; Kay, Douglas H. (Massachusetts Coll. of Pharmacy, Boston). J. Pharm. Sci., 57: 345-8(Feb. 1968).

Dithiocarbamates of exceptionally strong bases in the pyridine and pyrimidine series, e.g., the 1-alkyl-2- and 4-imino derivatives, were obtained. Significant protection in mice against ionizing radiation was provided by a dithiocarbamate of one of the strong bases, whereas the dithiocarbamates of weaker bases generally showed a lower level of protection. (auth)

28580 X-RAYS ARE VISIBLE: THE RADIATION PHOSPHENE. Ely, Thomas S. (Univ. of Rochester, N. Y.). J. Occup. Med., 10: 9-13(Jan. 1968).

At this point, the existence of the phenomenon of radiation phosphene cannot be denied. Except for refraction by the ocular structures, radiation produces many of the objective and subjective effects of light. Lipetz concludes that all findings are consistent with, but do not prove, the hypothesis that the x ray phosphene is produced by a direct action of the rays on the visual purple of the rods, or, in sufficiently high intensity, on the corresponding photochemicals, the iodopsins of the cones. It would seem that the greatest potential application of the x ray phosphene is in the preoperative evaluation of retinal function in eyes which cannot be examined with light because of cloudy cornea, lens, or humors. Secondarily, the phenomenon may occasionally be useful in demonstrating and localizing a foreign body. Studies of the radiation phosphene have contributed knowledge to the fields of visual physiology and biological effects of radiation. Although there seems little doubt that x rays and γ rays can be seen well below what would constitute a "permissible" occupational dose, it is hard to see how this phenomenon could serve any routine use in radiation protection. However, the radiation phosphene may be involved in the flash of light reported by victims of very high acute doses of ionizing radiation in accidental exposures. (auth)

28581 THE PROBLEM OF THE DEGENERATION OF GLIOMAS FOLLOWING X IRRADIATION. Siedschlag, W. D.; Wendt, F. (Univ., Berlin). Zentralbl. Neurochir., 26: 323-6(1965). (In German).

Following surgery for removal of a spongioblastoma a 30 yr old patient was irradiated with a total of 8700 R, administered as 2700 R each to the temporal, parietal, and parieto–occipital regions. Within a half yr there was recurrence of symptoms, and histological findings showed large areas of necrosis, spindle-shaped tumor cells, round nuclei, numerous atypical mitoses, and hemorrhagic areas. The tumor appeared to be a fusiform glioblastoma. The causes of the malignant transformation of the tumor following irradiation were not evident. Excessive irradiation may have been one factor, but whether necrotic processes favored tumor induction remains speculative. (BBB)

28582 RADIOISOTOPES IN MEDICINE. 2. THE LOCALIZATION OF SPACE-OCCUPYING LESIONS. Andrews, J. T. (Royal Melbourne Hospital). Med. J. Aust., 1: 353-4(Feb. 18, 1967).

Recent advances in the use of the radioisotopes in clinical diagnosis are reviewed, with data on lowered patient exposure by selective use of newly available isotopes: ^{125}I, ^{131}I, ^{47}Ca, ^{85}Sr, ^{32}P, ^{99m}Tc, ^{198}Au, ^{197}Hg, ^{203}Hg, ^{51}Cr, and ^{75}Se. The isotope usually used for thyroid scanning is ^{131}I, a β and γ emitter with a half life of 8 days and a principle γ ray energy of 360 keV. It is possible to use ^{125}I as an alternative, since it gives a softer γ ray emission, which is an advantage, but it has a half life of 60 days, which may be disadvantageous. Scans of the thyroid and neck require up to about 50 μCi of ^{131}I, but for distant metastases up to 500 μCi may be required. More recently, technetium (^{99m}Tc) has been used for thyroid scans. For localization of metastases in bone, ^{47}Ca with a half life of 4.8 days, or ^{85}Sr, with a half life of 64 days, can be used. Both are γ emitters; ^{85}Sr decays to stable rubidium (^{86}Rb), emitting a γ ray of 0.51 MeV. The ^{85}Sr is cheaper and has a longer shelf life. It gives a little more radiation exposure to the patient than ^{47}Ca, but this is not so critical in the types of cases considered. A dose of 20 to 30 μCi intravenously is usually sufficient, and gives a whole-body dose of about 0.5 rad, which is not excessive. Radiophosphorus can be used to detect early carcinomas of the vulva, and to help differentiate malignant from benign intraocular lesions. The radiation dose received by the patient is not excessive if 0.5 mCi of ^{32}P is given for these tests, particularly as many of the patients are elderly. Technetium-99m is a pure γ emitter of 140 keV, and is an excellent isotope for scanning (a dose of up to 10 mCi without the patients receiving excessive radiation). For a 10 mCi dose, the patient will receive up to about 1 rad on each of the unblocked thyroid, stomach, large bowel, and bladder. It is the current radioisotope of choice for brain scanning. Of the available isotopes, ^{203}Hg and ^{197}Hg, with physical half lives of 47 and 2.7 days, respectively, combined in a mercury diuretic such as chlormerodrin, and used for renal or braining scanning, ^{197}Hg is usually preferred because of the lower radiation dose to the kidneys. About 100 μCi of the isotope is needed for a renal scan, and the dose is given intravenously. Radioselenium (^{75}Se), a γ-emitter, is suitable for external scanning, and is used for examination of the pancreas and the parathyroids.

In the pancreas, the effective half life is 56 days, and with a dose of 200 μCi, a body burden of up to 1.3 rad is received. (BBB)

28583 THE CHANGES INDUCED IN THE ATYPICAL VESSELS OF UTERINE CARCINOMA BY TELECOBALT IRRADIATION. Ganse, R. (Frauenklinik, Dresden). Geburtsh. Frauenheilk., 27: 467-80(May 1967). (In German).

The degeneration and destruction of atypical blood vessels followed by atrophy of the mucosal tissue in stage II uterine cervix carcinoma irradiated with ^{60}Co was demonstrated by colpophotography. In most of the cases studied the atypical vessels showed degeneration after the first series of irradiation treatments. The tissues did not become sclerosed and eroded after ^{60}Co γ irradiation as observed after Ra treatment. The uterine tissue remained more intact. In addition, after ^{60}Co irradiation the atypical vessels did not reappear, as they sometimes did after Ra irradiation treatment. (BBB)

28584 RADIOIODINE-LABELED SUBSTANCES FOUND IN THE CIRCULATION IN CERTAIN PATIENTS WITH THYROID CANCER. Vallee, G. (Centre de Recherches du Service Central de Radioisotopes du Groupe Hospitalier Necker-Infants Malades, Paris). Lutte Cancer, 42: 16-17(Mar.-Apr. 1965). (In French).

The distribution of radioiodine in plasma constituents provided data on the diagnosis and pathogenesis of thyroid cancer. After administration of radioiodine, in addition to incorporation of isotope into the thyroid gland itself, labeled products of the gland appeared in the plasma. This organic radioiodide fraction increased with time and normally consisted entirely of radioiodinated thyroid hormone (thyroxine). In some pathologic instances a third nonhormonal radioiodinated protein fraction appeared in plasma. This abnormal protein was characteristic of thyroid cancer, but was also found in non-neoplastic goiter. Studies are described in which the presence of this radioiodinated abnormal protein was studied before and after thyroidectomy in radioiodine-treated patients. In certain cases of thyroid cancer a high level of the abnormal fraction was found. (BBB)

28585 VALUE OF TELECOBALT GAMMAGRAPHY IN PLANNING OF THE TREATMENT OF MALIGNANT TUMOURS. Wasilewski, M.; Nowakowski, W.; Starzynska, T. (Inst. of Oncology, Warsaw). Radiobiol.-Radiother., 8: 435-43(1967).

A technique for making radiographs with the use of the telecobalt unit is discussed and attention is called to usefulness of the films available in Poland and the value of using the intensifying lead screens. Radiographs demonstrate usefulness of this method in planning the treatment of malignant tumors of various localization. In the area of the head and neck, ^{60}Co gammagraphy permits localized portion of the site of the larynx, the tongue, pharyngeal cavity and bone structures of the visceral skull in the position in which the patient is irradiated. In the thorax the radiographs made with ^{60}Co in the position of irradiation enable an exact estimation of the area of tumor invasion in a frontal plane. In the pelvis this technique is useful and helpful in planning the treatment of carcinoma of the uterus and the ovaries. Demonstration of the vagina by air contrast and of bone walls of the pelvis permits the accurate determination of the area for irradiation. In patients with tumors of the bronchi and the mediastinum radiological pictures obtained with the telecobalt unit were compared with roentgenographs obtained with conventional technique. In some cases it was noted that ^{60}Co films often gave a more accurate picture of the lesion. (auth)

28586 PELVIC OSTEORADIONECROSES FOLLOWING BIAXIAL TELECOBALT IRRADIATION OF FEMALE GENITAL CARCINOMA. Banaschak, A.; Gietzelt, F.; Schubert, H. (Humboldt-Univ., Berlin). Radiobiol.-Radiother., 8: 423-34(1967). (In German).

From 1960 to 1965 a total of 905 patients obtained primary or postoperative radiation therapy for a carcinoma colli uteri of stages 1 to 4 with the telecobalt unit Mobaltron in the Geschwulstklinik of Charité. Of these 905 patients an osteoradionecrosis leading to fractures was found in 12 cases = 1.3 per cent within the period of observation. The earliest occurrence of fractures was about six months, the latest one about 14 months after radiation therapy was finished. The average age of patients suffering from an osteoradionecrosis was 64.3 years whereas the average age of all patients treated was 52.8 years. Ten of the twelve patients already showed degenerative changes of the hip joint of different severity before radiation therapy. Women in the menopause with simultaneous degenerative osseous changes were more endangered by fractures than others. However, it must not be concluded that a lower dose may be applied than that necessary for annihilating the tumor. (auth)

28587 PRELIMINARY RESULTS OF RADIATION THERAPY OF VULVA CARCINOMA WITH FAST ELECTRONS. Banaschak, A.; Hoppe, D. (Humboldt-Univ., Berlin). Radiobiol.-Radiother., 8: 413-18(1967). (In German).

At the Geschwulstklinik of Charité 103 vulva carcinomas were treated with fast electrons from the orbital accelerator Betatron from 1960 to 1964. The principal irradiation of the inguinal regions in the presence of a vulva carcinoma from 1963 significantly decreased the tendency to recidivations. Since 1963 our results have improved. In 1961 and 1962 the inguinal regions were not irradiated in every case. This had a disadvantageous effect and the quota of recidivations was increased. The increase of the operating energy from 6 to 17.3 MeV had an advantageous effect expressed in the better results in 1962 and 1963. By the displacement of the effective operation into a depth of 4 to 5 cm also deeper lymph passages were covered. The energy of 17.3 MeV for betatron irradiation should be kept independently of the volume of the vulva tumor. Undesirable side reactions, relatively frequent for betatron irradiations must, however, be put up with if the tumor shall be annihilated. The state of some patients free from recidivations was clearly spoiled by indurative changes in the area of irradiation. For the short time of observation and the low number of vulva carcinomas treated with fast electrons it may not be stated whether this therapy is superior to the conventional methods, radium puncture and contact therapy. (auth)

28588 ABOUT TELECOBALT IRRADIATION OF MALIGNANT LYMPHOMAS (HODGKINS DISEASE, LYMPHORETICULOSARCOMA) FROM 100 PATIENTS. Gyenes, G. (Staatliche Onkologische Instituts, Budapest). Radiobiol.-Radiother., 8: 401-11(1967). (In German).

From 100 patients irradiated with telecobalt for malignant lymphomas, indication, method of treatment and preliminary results are reported. The author establishes that telecobalt irradiation is indicated in the radiation therapy of malignant lymphomas especially at the later stages for recidivations and metastases sometimes even for primary cases. Based on the favorable physical and radiobiological properties of ^{60}Co radiation an effective radiation therapy without considerable side effects is possible even for greater volumes. (auth)

28589 A SIMPLIFIED TECHNIC FOR THE TRANSFER OF ^{133}Xe. Marks, Asher; Chervony, Isaac (Univ. of Miami, Fla.). Radiology, 90: 800(Apr. 1968).

A simplified method is described for the transfer of ^{133}Xe from glass vial containers used for shipping. The method makes use of a flow-through system that rinses essentially all of the gas into a mercury-filled tonometer. The glass vial containing ^{133}Xe is inserted into rubber tubing. After all connections are made, the vial is crushed through the wall of the tubing. Empty contaminated vials can be left in the tubing during storage behind suitable shielding. (C.H.)

28590 AN EASILY OPERATED COLPOSTAT CONTRIBUTION TO THE TECHNIQUE OF COLLUM CARCINOMA RADIUM TREATMENT. Alberti, K. (Onkologische Abteilung des Krankenhauses, Cheb, Czech.). Radiobiol.-Radiother., 8: 445-54 (1967). (In German).

An applicator for uterovaginal radium therapy was described for which a central conically tapered screw splays the ovoid carriers being arranged in scissor-shape on the one hand and connects the shaft with the colpostat before application and releases it automatically after application on the other. Application may be performed quickly and sparingly for the patients. During application the hand of the physician is always at a distance of 25 to 30 cm from the radium. (auth)

28591 ABOUT THE RADIOPROTECTIVE EFFECT OF SOME CHOLINOMIMETICS. Effler, K.; Staib, A. H. (Carl Gustav Carus Medizinische Akademie, Dresden). Radiobiol.-Radiother., 8: 479-83(1967). (In German).

Cholinometics Arekoline, Tremorine and Oxotremorine show besides the hypothermic effect, depending on dose and environmental temperature, a significant radioprotective effect against lethal and sublethal doses in mice. As in the pharmacological suppression of hypothermia by cholinolytics, the radioprotective effect disappears, too, this is maintained for the physical elimination of the decrease of body temperature. Hypothermia is not the decisive factor for the radioprotective effect of the investigated substances. The part of hypoxia in the mechanism of effects of radioprotection are discussed. (auth)

28592 PRELIMINARY EXPERIMENTAL EXPERIENCES WITH OXYGEN POTENTIATED RADIATION THERAPY. Jona, G.; Miltenyi, L. (Univ., Debrecen, Hungary). Radiobiol.-Radiother., 8: 497-500(1967). (In German).

The radiosensitivity of tumors depends on their blood supply i.e., on their oxygenation. By increasing the oxygen content of

the malignant tissue theoretically an increased radiosensitivity may be expected. VX-2 cancer carrying rabbits were infused with 0.25 per cent H_2O_2 solution after the artery leading to the tumor was catheterized; oxygen content of the tumor was registered. The tumors were irradiated after infusion was finished. The tumor volumes were determined before and after therapy. VX-2 cancer carrying rabbits served as controls who were only irradiated. The control animals died during the period of observation of their tumors whereas the tumors of the locally hyperoxygenized and irradiated animals significantly decreased. (auth)

28593 PRINCIPLES, INDICATION, AND PROSPECTS FOR PREOPERATIVE IRRADIATION. Bloedorn, Fernando (Univ. of Maryland, Baltimore). CA - Cancer J. Clin., 17: 70-3(Mar.-Apr. 1967).

Radiobiologic bases for preoperative radiotherapy are discussed, with attention to optimal doses under various conditions and prevention of radioinduced complications. The periphery of the tumor is more sensitive than its core, especially with tumors of large volume. Even if irradiation does not sterilize the whole tumor, it may make inoperable tumors operable and diminish the possibilities of leaving tumor extension beyond the resected volume. For the same histologic group, the radiosensitivity of a tumor is in inverse ratio to its volume (or number of cells). Thus the small nests of isolated cells which surround most malignant tumors may be controlled with smaller doses of radiation than are sufficient to control a larger primary tumor. If the integrity of the tumor vascular bed is important to obtain better effects from irradiation, its application prior to surgery will be more efficacious than postoperative irradiation. The production of metastases or implants may be reduced by preoperative irradiation since the malignant cells, seeded after the treatment, are modified cells with reduced capacity for mitosis. With the use of supervoltage therapy it is possible to perform surgery after a radical dose of irradiation with a low incidence of complications. Surgical intervention should be made ideally when the acute reaction produced by irradiation has subsided, before the late changes of marked endoarteritis and fibrosis have set in and after a maximum regression of the tumor has been effected. The ideal waiting period is between four and eight weeks, probably about six weeks for most cases. A higher incidence of complications may occur with the use of preoperative irradiation, but this risk is acceptable, providing the gains in survival rate are well above the losses due to complications. To attain the maximum benefit and avoid complications it is necessary to understand, as thoroughly as possible, the radiobiologic principles involved in this type of combined treatment, to use adequate techniques of irradiation and surgery, and to time the operation to obtain the maximum benefit with a minimum of interference of the healing processes. (BBB)

28594 LASER DESTRUCTION OF EXPERIMENTAL TUMORS: STATE OF THE ART AND PROTECTION OF PERSONNEL. Hoye, Robert C.; Riggle, Grant C.; Ketcham, Alfred S. (National Cancer Inst., Bethesda, Md.). Amer. Ind. Hyg. Ass. J., 29: 173-80(Mar.-Apr. 1968).

Experiments with high energy neodymium pulsed laser to destroy tumors in mice, rabbits, and monkeys, indicated that the rapid and precise destruction of localized tumors is possible. When combined with other anticancer modalities a 3 to 4 fold improvement in the cure rate of tumor occurred. These encouraging results were overshadowed by secondary effects associated with the laser-tissue interaction. These effects of pressure and varying degrees of cellular damage resulted in the dissemination of viable tumor into the air and tissue planes resulting in lethal secondary tumor growths. During the course of these studies, protection of laser personnel was a prime consideration. For the safe operation of equipment, warning beacons, door interlocks, remote operation facilities and special environment conditions are all necessary. Various devices for the containment of the particles in the laser plume were developed and successfully used. (auth)

28595 DETERMINATION OF GLOMERULAR FILTRATION RATE BY EXTERNAL MONITORING OF ^{51}Cr LABELED INULIN. Johnson, A. E.; Gollan, F. (Veterans Administration Hospital, Coral Gables, Fla. Univ. of Miami, Coral Gables, Fla.) Int. J. Appl. Radiat. Isotop., 19: 43-7(Jan. 1968).

A ^{51}Cr-labeled inulin which is stable in the laboratory as well as in vivo was prepared. There is no unbound radioactivity to correct for and, in the dog, simultaneous glomerular filtration rate studies using stable and radioactive inulin with urine and plasma sampling, gave identical results. Dogs were given a single intravenous injection of 100μ ^{51}Cr-labeled inulin. Fifteen minutes later scintillation detectors were placed over the heart and kidneys, and the rate of disappearance of radioactivity was recorded for a 15-min period. A plasma sample was taken corresponding to the midpoint of the curve for calculation of absolute values. The substitution of external monitoring of each kidney for differential catheterization of both ureters and the substitution of external monitoring of heart or forearm for repeated blood sampling, offer advantages in time, accuracy, convenience and safety, unobtainable with the chemical inulin procedures. (auth)

28596 PARATHYROID SCINTISCANNING. Potchen, E. James; Watts, Hugh G.; Awwad, M. K. (Edward Mallinckrodt Inst. of Radiology, St. Louis). Radiol. Clin. N. Amer., 5: 267-7(Aug. 1967).

Experimental and clinical data on visualization of the parathyroid gland with ^{75}Se-selenomethionine are presented. In a human parathyroid adenoma removed one hr after intravenous administration of ^{75}Se-selenomethionine, the parathyroid activity was six times greater than the blood act and seven times greater than the thyroid activity that was suppressed by pretreatment with triiodothyronine. The time sequence of rat parathyroid ^{75}Se-selenomethionine accretion is shown. In the rat, the parathyroid specific activity had an early peak in isotope concentration at 20 min, followed by a decline over two hr. The time of this parathyroid peak corresponded to the time of lowest blood concentration. On the basis of these studies, a clinical method was developed in which, four days after pretreatment with triiodothyronine, 250 μCi of ^{75}Se-selenomethionine (sp, act. 60 to 80 μCi/mg) was injected intravenously. Scanning was then begun five min later and continued for two to 2.5 hr. When a focus of isotopic accretion was identified on the neck scintiscan, the most common underlying pathologic finding was a parathyroid adenoma. In 80% of the false-positive scans an underlying thyroid adenoma was found at operation. The addition of simultaneous ^{125}I neck scans to rule out a nonsuppressed thyroid adenoma as the etiologic basis of a focus of ^{75}Se-selenomethionine accretion was helpful in decreasing the instances of false-positive parathyroid scans. (BBB)

28597 RHEUMATOID ARTHRITIS IN HIROSHIMA AND NAGASAKI. Burch, P. R. J. (Univ. of Leeds, Eng.). Arthritis Rheum., 10: 403(Aug. 1967).

Criticisms are advanced against the statement of J. W. Wood et al. (ibid., 10: 21(Feb. 1967)) that their failure to find an association between the prevalence of rheumatoid arthritis and radiation dose in the Hiroshima and Nagasaki populations offers strong evidence against the author's hypothesis that somatic mutations are required to initiate the disease process. The proportional increase of mutant clones produced by a given dose of ionizing radiation should depend, among other factors, upon the relation between the radiation mutation coefficient α, and the average rate of spontaneous mutation $\underline{m}$, where α is the average number of induced mutations, per gene at risk, per cell at risk, per unit dose, and $\underline{m}$ is the average number of spontaneous mutations, per gene at risk, per cell at risk, per year. If the value of the ratio $\alpha/\underline{m}$ relevant to the loci at risk is small enough, then even large doses of radiation will be without detectable effect. In the context of arthritic disease the absolute values of α and of $\underline{m}$, and also of the ratio $\alpha/\underline{m}$, are unknown. Accordingly, it is impossible to make quantitative predictions about the effects of radiation on the incidence of rheumatoid arthritis. In the absence of such predictions, the claim of Wood et al. to have produced strong evidence against the author's somatic mutation hypothesis of arthritic disease is said to be unjustified. (BBB)

28598 DATA ON RADIATION-PROTECTIVE EFFECT OF SOME CYSTEINE-CYSTEAMINE DERIVATIVES. Hernadi, Ferenc; Kovacs, Peter; Bekesi, Istvan; Nagy, Zsolt (Medical Univ. of Debrecen, Hungary). Kiserl. Orvostud., 18: 434-8 (Aug. 1966). (In Hungarian).

The radioprotective effects of some dimethyl and tetramethyl derivatives of cysteine, cysteamine and their disulfides were studied in a microbiological system (E. coli B) and in a mammal (mouse C_3) exposed to x radiation. In the general formula of the above group of compounds, substitution of a dimethyl or tetramethyl group in the $(CH_2)_x$ carbon chain in the β position results in the decrease or disappearance of the good radioprotective effect of the basic compound. (JPRS)

28599 PREVENTION OF INCIDENTS AND ACCIDENTS IN SCINTIGRAPHY OF SUBARACHNOID SPACES OF THE SPINAL CORD. Gros, Ch. M.; Wackenheim, A.; Vrousos, C. (Univ., Strasbourg). J. Belge Radiol., 50: 163-4(1967). (In French).

Incidents occurring after injection of radioactive iodinated serum albumin for scintigraphy are described. Minor incidents can be prevented by use of fresh serum albumin or by use of cortisones mixed with serum albumin for intrathecal injection. (auth)

28600 ADVANCES IN THERAPEUTIC RADIOLOGY. Gaskill, William J.; Sklaroff, David M. J. Albert Einstein Med. Cent., 15: 313-15(July 1967).

The advantages of supervoltage generators such as ^{60}Co units over conventional 250 kV x-ray generators for radiotherapy are reviewed. The effectiveness of preoperative irradiation, hyperbaric oxygen, and intra-arterial injection of hydrogen peroxide are discussed. (C.O.)

28601 COLLIMATORS AND COUNTING SYSTEMS FOR BRAIN SCANNING. Matthews, C. M. E. (Hammersmith Hospital, London). Acta Radiol., Ther., Phys., Biol., 6: 464-80(Dec. 1967).

The design of collimators for low energy γ rays with uniform resolution with depth is discussed, and the effects of collimator efficiency and resolution on brain tumor detection is evaluated. It is estimated approximately that tumors in the middle of the head must be larger than 1.2 cm in diameter for detection using 10 mCi ^{99m}Tc. A method of calculating optimum collimator resolution is proposed. (auth)

28602 CURRENT RADIOLOGIC ADVANCES IN THE URINARY TRACT. Shapiro, Joel H.; Brotman, Marilyn Joyce; Goluboff, Bernard. J. Albert Einstein Med. Cent., 15: 270-8(July 1967).

Significant advances made in the radiographic diagnosis of urinary tract disease are discussed. Several of these areas, including renovascular hypertension, drip infusion pyelography, nephrotomography and voiding cystourethrography are highlighted. The role of radioactive isotope studies to evaluate renal disease is also discussed. (auth)

28603 DIAGNOSIS OF PULMONARY EMBOLIZATION WITH THE AID OF RADIOISOTOPE SCANNING. Shapiro, Bernard. J. Albert Einstein Med. Cent., 15: 309-12(July 1967).

Iodine-131-labeled macroaggregated albumin particles that ranged in size from 10 to 70 μ were used for lung scanning. The particles were observed to lodge almost entirely in the capillaries of the pulmonary arterial bed on the first passage through the lungs. Emboli were identified by areas in which no radioactive particles appeared. Problems in the interpretation of the scans were discussed; the scans were also compared to chest x-ray films. (C.O.)

28604 HYDROGEN SULFIDE-RADIOMIMETIC EFFECTS AND RADIOPROTECTIVE EFFECTS ON DROSOPHILA EGGS. Matter, B. E. (Eidgenoessiche Technesche Hochschule, Zurich). Radiol. Clin. Biol., 36: 299-307(1967). (In German).

Inseminated newly laid eggs of Drosophila melanogaster were treated with hydrogen sulfide and/or x rays. The rates of H_2S-induced mortality vary in the same way with the different nuclear division stages as the rates of radiation induced mortality, i.e., H_2S is radiomimetic. The x ray sensitivity of the H_2S-treated eggs was strongly reduced. It was concluded that the radioprotecting agent H_2S acts as a radical scavenger. (auth)

28605 NEW RADIOISOTOPE TECHNIQUES. Shapiro, Bernard. J. Albert Einstein Med. Cent., 15: 216-23(July 1967).

Developments in three general areas of nuclear medicine, i.e., radioisotope scanning, radioisotope dynamic function studies, and radioisotope clinical chemistry are reviewed. Emphasis is given to new techniques related to advanced equipment and the availability of new isotopes. (C.O.)

28606 PROTECTIVE EFFECT OF CYSTEAMINE AT FRACTIONATED IRRADIATION. II. SHORTENING OF LIFE SPAN. Nelson, Arne; Hertzberg, Ola; Roennbaeck, Curt (Research Institute of National Defence, Sundbyberg, Sweden). Acta Radiol., Ther., Phys., Biol., 6: 449-63(Dec. 1967).

Groups of mice were exposed to repeated doses of 80 R and 160 R at various time intervals to study the protective effect of cysteamine against late effects from sub-lethal doses of irradiation. The accumulated doses selected to fall definitely in the range between sub-lethal and supra-lethal doses. Half the number of animals in each group were given cysteamine before each irradiation. The conclusion may be drawn that in addition to the well-known protective effect against acute injuries, cysteamine also protects against such chronic effects as shortening of the life span. (auth)

28607 USE OF RADIOISOTOPES IN STUDIES OF THE GASTROINTESTINAL TRACT. Shapiro, Bernard. J. Albert Einstein Med. Cent., 15: 263-9(July 1967).

Major applications of radioisotopes for study of the gastrointestinal tract are reviewed. Iodine-131-labeled oleic acid and triolein absorption as used in the study of pancreatic disease and disorders of intestinal absorption are discussed. Chromium-51-labeled erythrocytes as used in the study of intestinal bleeding, and ^{51}Cr-labeled albumin as used in the study of intestinal protein loss are also included. Consideration is given to the use of colloidal ^{198}Au, ^{131}I-labeled Rose Bengal, and ^{99m}Tc-sulfur colloid for liver scanning. The limitations and performance of each are discussed. (C.O.)

28608 TREATMENT OF SUPERFICIAL TUMOURS OF MEDIUM OR LOW RADIOSENSITIVITY WITH A RELATIVELY SHORT SSD CAESIUM TELETHERAPY UNIT. Flemming, J. A. C. (St. Thomas' Hospital, London). Brit. J. Radiol., 41: 199-204 (Mar. 1968).

The irradiation of tissues involved or potentially involved by tumors of moderate or low sensitivity, lying within 3 cm of the skin surface, by a ^{137}Cs γ teletherapy unit, operating at 20 to 25 cm SSD either alone or in combination with ^{60}Co γ teletherapy, is discussed. Skin doses, at the level of maximum build-up, 1 mm deep, of between 5,000 and 6,000 rads fractionated three times weekly and given over 28 to 35 days are well tolerated and could be increased. With reasonable sparing of the skin at such doses, the lower energy of the γ rays from cesium when compared with cobalt, on the other hand, allows of easier shielding and collimation of the beam. Doses to normal structures situated at a depth are reduced by decreasing the source-skin distance. The cesium unit described has also been used in combination with a large cobalt teletherapy unit, to some advantage, in treating the internal mammary nodes in breast cancer and carcinoma of the buccal mucosa by external irradiation. (auth)

28609 PRELIMINARY EXPERIMENTAL OBSERVATIONS ON ENDOARTERIAL INTRODUCTION OF RADIATING RESIN MICROSPHERES. Caldarola, L.; Sosi, S.; Badellino, F.; Calderini, P.; Cavalli, A. (Univ., Turin). Int. J. Appl. Radiat. Isotop., 19: 135-9(Feb. 1968).

Studies on different groups of rabbits confirmed in vivo the stability of the bond between the ^{32}P and the cationic resin microspheres normally used in the endoarterial therapy of tumors. The microspheres were also found to be in stable arrest in the target area following introduction into several organs: the hind limb (via the femoral artery); the bowel (via the mesenteric artery); the kidney (via the renal artery), and the liver (via the portal vein). The homogeneity of distribution depends on the quantity of resin injected, on the volume of the organ, on its blood supply, and on the size of the microspheres themselves. (auth)

28610 CYTOCHEMICAL ANALYSIS OF THE EFFECT IN INCREASING THE CONTENT OF PROTEIN THIOL GROUPS IN MOUSE BONE MARROW CELLS. [PRODUCED BY RADIOPROTECTIVE AGENTS]. Graevskii, E. Ya.; Dentsova, G. V. Radiobiologiya, 7: 438-40(1967). (In Russian).

The effects of cysteamine (3.0 mg per animal), 5-methoxytryptamine (1.5 mg per animal), and anoxia in increasing the content of protein thiol groups in the bone marrow of mice were investigated by application of cytochemical techniques. Cysteamine did not significantly increase the content of cells in bone marrow, whereas 5-methoxytryptamine or anoxia produced a marked increase. The results indicated that both protein and non-protein thiol groups protected against radiation. (JPRS)

28611 COMPARATIVE EFFECTIVENESS OF DIFFERENT SULFHYDRYL COMPOUNDS AS RADIOPROTECTORS. Gusareva, E. V. Radiobiologiya, 7: 446-51(1967). (In Russian).

Sulfhydryl compounds were investigated in isolated cells and in intact animals to determine a possible relation between radioprotective action and compound structure. In the first of two experimental series, Erlich ascites carcinoma cells were used to study the following; cystamine (.025 to 3.6 mg/ml), butylmercaptan (0.4 to 20 mg/ml), ethylmercaptan (0.4 to 2.0 mg/ml), sodium thioglycolate (0.4 to 3.0 mg/ml), mercaptoethanol (0.1 to 3.0 mg/ml) and unithiol (0.5 to 10.0 mg/ml). The cells were centrifuged, washed, and incubated for 15 min at 37° with a given compound. Then, the cells were x-irradiated (200 kv, 15 mamp, 0.75-mm Al and 0.5-mm Cu filters, 40-cm focal length, 60 R/min) with a 700 R dose, and injected intraperitoneally into intact mice. In 24 hr the animals were killed and smears were prepared to determine the mitotic index, number of cells with chromosomal rearrangements, and number of stained cells. In the second experimental series, mice were administered the various compounds subcutaneously 15 min before gamma irradiation (^{60}Co unit, 218 R/min) with a 900 R dose. Radioprotective action was based on survival of animals for a 30 day period. Results show that all the sulfhydryl compounds tested in the given doses do not display any significant radioprotective effect on the depressed mitotic activity, but clearly reduce the percentage of cells with chromosomal rearrangements. In the experiments on mice, only cystamine (3.0 mg per mouse) and unithiol (14.0 mg per mouse) were found to display a definite radioprotective effect. It was noted in both series that whether an increased dose of any of the compounds tended to increase the radioprotective effect depends largely on

the concentration of sulfhydryl groups in a medium, with relatively little dependence on the structure of the donor compound. (ATD)

28612 RADIOSTRONTIUM ABSORPTION IN MAN: SUPPRESSION BY CALCIUM AND BY SODIUM ALGINATE. Hodgkinson, A.; Nordin, B. E. C.; Hambleton, J.; Oxby, C. B. (General Infirmary, Leeds, Eng.). Can. Med. Ass. J., 97: 1139-43(Nov. 4, 1967).

Calcium chloride and sodium alginate, administered orally, were shown to inhibit the intestinal absorption of radiostrontium by adult human subjects. Sodium alginate also inhibited the absorption of radiocalcium but to less extent than radiostrontium. Measurements of fecal magnesium, iron, copper and zinc indicated that sodium alginate also inhibited the absorption of these metals. Maximum inhibition of radiostrontium intake was observed when sodium alginate was administered simultaneously with the isotope. Alginate samples having a relatively high guluronic/mannuronic acid ratio were slightly more effective in binding strontium, magnesium and calcium than those having a low guluronic/mannuronic acid ratio. The affinity of sodium alginate for ferric iron, strontium, calcium and magnesium decreased in the order Fe > Sr > Ca > Mg, the binding of one molecule of these elements being accompanied by the release of two or three molecules of sodium, depending upon the valency. Binding was dependent upon pH, being virtually abolished below pH 3.0. It is concluded that the binding of metallic ions by sodium alginate involves an ion-exchange mechanism. (auth)

28613 SUMMARY OF POPULATION EXPOSURE TO X RAYS IN THE UNITED STATES, 1964. Sydenstricker, Myrtle C. (National Center for Radiological Health, Rockville, Md.). Radiol. Health Data Rep., 8: 367-73(July 1967).

A report on the Public Health Service x-ray exposure study, Public Health Service Publication No. 1519, is presented. It is estimated that 58% of the 187 million civilian noninstitutional population of the United States had one or more x-ray visits. The estimated annual dental x-ray rate declined from 27.4 per 100 persons in 1961 to 26.8 in 1964. The estimated annual rate of medical x-ray visits increased from 47.9 per 100 persons in 1961 to 49.8 in 1964. Of the 173 million x-ray examinations or procedures performed during these visits, 105 million were radiographic, 54 million dental, 10.5 million fluoroscopic, and 3.5 million x-ray therapy. The estimated number of x-ray films taken were 506 million. (auth)

28614 CEREBRAL BLOOD FLOW STUDIED WITH THE IMAGE INTENSIFIER CAMERA. Johnson, Philip M.; Hilal, Sadek K.; Wood, Ernest H. (Columbia-Presbyterian Medical Center, New York). Radiology, 90: 347-8(Feb. 1968).

Cerebral scintiphotography with the Ter-Pogossian-Picker image intensifier scintillation camera after the administration of ^{99}Tc-labeled technetium pertechnetate or ^{133}Xe permits rapid serial display of cerebral blood flow. Perfusion abnormalities due to stroke and other cerebrovascular diseases were demonstrated in several patients. Further investigation will determine the detectability of small or deep-seated vascular abnormalities. Although certain disadvantages, particularly the lack of numerical data, remain to be resolved, the present capabilities of this instrument are useful for evaluating the patient suspected of stroke or other diseases of the central nervous system and provide a valuable means for study of the cerebral circulation. (auth)

28615 CLINICAL SAFETY IN LOW-MEGAVOLT ELECTRON THERAPY. Smedal, Magnus I.; Salzman, Ferdinand; Trump, John G.; Costey, George C.; Wright, Kenneth A. (Massachusetts Inst. of Tech., Cambridge). Radiology, 90: 370-1 (Feb. 1968).

Low-megavolt electrons produced by accelerators offer clinical advantages over low-energy x rays in that they can be used to treat large-area superficial tumors or extensive superficial diseases, such as mycosis fungoides. Typical daily doses used involve an incident electronic charge of about 10^{-9} coulombs/cm^2. Electron therapy planning must take into account the gram rad dose due to both electrons and the accompanying x ray background that results in whole-body irradiation that may result in the production of irreversible blood changes. A method is described that was developed to obtain a uniform electron dose over an area of 700 cm^2 while keeping the x ray background to a low level. A low atomic number absorber shaped like the hub and spokes of a wagon wheel and placed midway between the exit window of the accelerator tube and the patient was used to reduce electron flux in the central part of the beam so that the dose distribution, with the aid of air scattering, is quite uniform over a circle 30 cm in diameter. (C.H.)

28616 EYE LENS PROTECTION IN THE TREATMENT OF RETINOBLASTOMA WITH HIGH-ENERGY ELECTRONS. Griem, Melvin L.; Ernest, J. Terry; Rozenfeld, Martin L.; Newell, Frank W. (Univ. of Chicago). Radiology, 90: 351-2(Feb. 1968).

A method for protecting the lens of the eye during x ray therapy for tumor is described. A copper shield is attached to a contact lens during irradiation with 10 MeV electrons. No neutrons are generated in the copper with this low dose, so the irradiation of the equator of the lens of the eye is minimal. Isodose curves for field therapy and convergent beam therapy are presented. (auth)

28617 INVESTIGATION OF THE NATURE OF THE RADIOPROTECTIVE ACTION OF CYSTEAMINE AND SODIUM THIOGLYCOLATE. Graevskii, E. Ya.; Gusareva, E. V.; Konstantinova, M. M.; Nekrasova, I. V.; Smirnova, I. B.; Sokolova, O. M.; Tarasenko, A. G. (Inst. of Morphology of Animals, Moscow). Radiobiologiya, 7: 579-86(1967). (In Russian).

Cells of Ehrlich's ascites carcinoma (hyperdiploid strain) were administered 700 R at 58 R/minute at 0°, 21°, and 37° and immediately transferred to the abdominal cavity of mice (1 ml containing 10^7 cells). After 24 hours the mice were killed and the ascites extracted from them were used to prepare smears that were fixed and stained. The percentage of cells with chromosome aberrations served as the criterion. Cysteamine and sodium thioglycolate tagged with ^{35}S were added to the suspension (0.005 to 3.6 and 0.05 to 3.0 mg/ml respectively) 15 minutes after irradiation. The radiosensitivity of intact cells and the radioprotective effect of cysteamine were found to depend strongly on the temperature at the time of irradiation. Although much less sodium thioglycolate was accumulated than cysteamine, it was much more effective, apparently because of the greater reactivity of its thiol groups. (JPRS)

28618 TOPICAL TREATMENT OF RADIATION DERMATITIS WITH BETHAMETHASONE-17-VALERATE, VASELINE, AND EUCERINE: A DOUBLE-BLIND COMPARISON. Bjoernberg, Alf; Hellgren, Lars; Magnusson, Bertil; Mattsson, Inger; Rosengren, Bengt (Sahlgrenska Sjukhuset, Goteborg). Clin. Radiol., 18: 463-4(Oct. 1967).

In 26 patients x radiation dermatitis was provoked experimentally in four identical fields on normal skin on the thighs. The fields were randomly selected for treatment with bethamethasone-17-valerate ointment, vaseline, and eucerin. One field was left untreated as a control. The antiinflammatory effect on the radiation dermatitis of the different ointments was compared and double blind method was used. During the first five weeks after the radiation bethamethasone-17-valerate, a steroid ointment, had a significantly better effect than the conventional types of treatment. (auth)

28619 THYROID ISOTOPE SCANS: A NEWER METHOD. Love, Jesshill; Erickson, Douglas W.; Hartman, John R.; Stratton, Joe; Cailliet, Marilyn; Gueorev, Danielle; Brown, Stanley (Cancer Foundation of Santa Barbara, Calif.). Radiology, 90: 345-6 (Feb. 1968).

A method is described for scanning the thyroid gland after the oral administration of tracer doses of mixed ^{125}I and ^{131}I. The diffused scan renders an accumulation profile that more closely simulates the activity within the thyroid than that obtained by conventional scanning methods. (C.H.)

28620 I RADIOISOTOPI PER APPLICAZIONI INTERNE IN DIAGNOSTICA E TERAPIA. (Radioisotopes for Internal Application in Diagnostics and Therapy). Laconi, A.; Caffarelli, F.; Melfi, F. Firenze, Sansoni. 677p.

The study is limited to the use of radioisotopes internally in solid, ionic, or colloidal form. In the section on physics and technology, the data are compiled in as complete a fashion as possible for easy reference. The description of the instruments for detection and measurement is preceded by a discussion of the physical principles on which they are based. The theoretical principles of the dosimetry of β and γ sources of various forms are given, with emphasis on interstitial and endocavity radioisotope therapy with sealed sources. The technical and methodological principles of radiotherapeutic applications are discussed. The role of radioisotopes in biological processes and radioisotopes with specific deposition sites are considered in detail. (J.S.R.)

Radiation Effects on Animals

Refer also to abstracts 28274–28276, 28282–28284, 28286–28289, 28312, 28325, 28329, 28331, 28333, 28337, 28339, 28340, 28347–28349, 28355–28357, 28369, 28373–28375, 28392, 28397–28399, 28401–28403, 28405, 28406, 28410, 28411, 28415, 28417–28419, 28425–28427, 28429–28441, 28445, 28462, 28464, 28486, 28518, 28531–28534, 28537, 28541, 28543–28546, 28549, 28550, 28552–28556, 28563, 28566–28575, 28577, 28578, 28580, 28581, 28583, 28584, 28586, 28591, 28593, 28597, 28600, 28604, 28606, 28617, and 30409.

28621 (ANL-7278, pp 1-94) GENERAL RADIATION BIOLOGY. (Argonne National Lab., Ill.).

GAMMA RADIATION—effects on survival of squirrels; effects on survival of mice, effects of dose fractionation on; effects on growth of chickens, effects of exposure of embryos on; effects on hematopoiesis in mice, effects of dose fractionation and erythropoietin on; effects on mitosis in duodenal crypt cells of mice

X RADIATION—effects on synthesis of antibodies in rabbits, effects of colchicine on; effects on antigen localization in lymphoid follicles of rats; effects on survival of fish; effects on hematopoiesis in mice, effects of partial body shielding on; effects on blood circulation and survival of chick embryos; effects on growth of chickens, effects of exposure of embryos on; effects on testicular weight loss in mice in comparison to fission neutron; effects on DNA synthesis in regenerating liver of rats, effects of iodine-125-labeled IVDR on whole-body; effects on mitosis in cornea cells of mice; effects on mitosis of cultured mammalian cells, effects of hydroxyurea, leurocristine sulfate, and statolon on; effects on survival of cultured hamster cells; effects on intestinal flora of mice; effects on survival of mice, effects of bacterial infections and temperature on

NEUTRONS, FISSION—effects on hematopoiesis in mice, effects of dose fractionation and erythropoietin on; effects on rats, effects of 2,7-diacetylaminofluorene and gum acacia on carcinogenic

NEUTRONS, FAST—effects on mitosis in liver of mice, effects of hepatectomy on

NEUTRONS—effects on survival of cultured hamster cells

MICE—genetics of ageing and longevity in; life span of erythrocytes in, use of iron-59 tracer to determine; life span of cells of mucosa in intestine of germ-free, effects of bacterial contamination on; life span of cells of intestine in, tracer study of; radioisotope retention in blood and soft tissue of, strontium-85, -90, and yttrium-90; effects of progesterone on pregnant, in relation to reproductive ability of female progeny; hemogram of Salmonella-infected, following turpentine injection; reproduction in, determination of age of; size of litters of, effects of light on; incidence of nematode infection in, methods for determination of

ERYTHROCYTES—life span in rats, iron-59 tracer study of

CELLS—analysis of mitotic cycle of Chinese hamster, use of colcemid and tritium-labeled thymidine for; life span in intestines of rats, tritium tracer study of; dynamics of populations of, mathematical analysis of; ultrastructure of mast, electron microscopic study of

ANIMALS—laboratory, review of literature on; control of Pseudomonas infections in breeding colonies of laboratory; laboratory, list of species and care of, at Argonne National Laboratory

DISEASES, INFECTIONS—murine pneumonia, etiology of

IMMUNE REACTIONS—effects of hibernation on, in nematode-infected squirrels; effects of actinomycin on, in organ cultures

SQUIRRELS—biochemistry of brown fat and liver of

RABBITS—hemolysin response in, effects of BUDR on (E.R.B.)

28622 (ANL-7278, pp 95-131) TOXICITY AND METABOLISM OF RADIONUCLIDES. (Argonne National Lab., Ill.).

DOGS—radioisotope metabolism in, cerium-144, cesium-137, and iodine-131; radiation effects on hematology and survival of, effects of dose on cesium-137 and cobalt 60 γ; radiation effects on hematology, pathology, and survival of, effects of continuous exposure on γ; radiation effects on volume of erythrocytes in beagle, cerium-144, cesium-137, and cobalt-60 γ; cerium-144 toxicity in beagle; incidence of disease in colonies of beagle; weights of organs in beagle, in relation to total body weight; iodine-125 uptake by thyroid of, effects of age and sex on; radiation effects on function of thyroid gland in, effects of surgery on x; radiography of lymph nodes in, use of ethiodol for contrast medium for; radiation effects on beagle, development of physiological telemetering systems for determining; content of glucose, protein, and urea nitrogen in serum of beagle; radiography of alveolar bones in, effects of age and sex on; studies of beagle, development of computer based information retrieval system for use in long-term

TEETH—radiation dose to human, during dental radiography, use of thermoluminescent microdosimeters for determination of x (H.L.W.)

28623 (ANL-7278, pp 132-43) MECHANISMS OF CARCINOGENESIS AND NEOPLASTIC GROWTH. (Argonne National Lab., Ill.).

MICE—radioinduced tumors in, beta; radioinduced sarcomas in, following plutonium-239 injection, α

RATS—radioinduced carcinomas in, effects of Teflon implants on x; radioinduced tumors in mammary glands of, determination of growth rate of plutonium-239 α and x; radioinduced sarcomas in, following subcutaneous implantation of strontium-90 and yttrium-90, β; radioinduced sarcomas in, following plutonium-239 injection, α; radioinduced mammary carcinomas in, effects of mammary gland DNA synthesis on whole-body x; metabolism of glycogen in, effects of glucagon and hydrocortisone on; radiation effects on liver of, effects of diethylnitrosamine and phenobarbital on γ; regulation of enzymes in liver of, effects of diet, cortisone, and phenobarbital on

EMBRYOS—growth of avian and mammalian, mathematical model for dynamics of (H.L.W.)

28624 (NYO-2147-13) FISSION PRODUCT METABOLISM AND RESPONSE IN LABORATORY AND DOMESTIC ANIMALS AND PLANNING STUDY FOR EVALUATION OF RADIOACTIVE CONTAMINATION OF THE FOOD CHAIN. Progress Report, January 1–December 31, 1967. Comar, C. L. (New York State Veterinary Coll., Ithaca. Dept. of Physical Biology). Contract AT(30-1)-2147. 224p. Dep. CFSTI.

Separate abstracts were prepared for the 24 papers in this report. A list of 62 publications is included. (H.L.W.)

For abstracts of individual papers see: 28275–28282, 28398, 28448–28455, 28538–28540, 28625–28627, and 30408.

28625 (NYO-2147-13, pp 181) OLFACTORY X-RAY DETECTION. Gasteiger, E. L. (New York State Veterinary Coll., Ithaca. Dept. of Physical Biology).

That rats detect x ray by way of their olfactory systems is well established. Whether the detection is mediated by a primary process within the cell or by production of gaseous odorants in the nasal passage is still to be determined. Masking of x ray detection by introduction of ozone (O_3) into the operant conditioning box supported the latter possibility. Further evidence involving O_3 in the mechanism was found by establishing that O_3 and x ray could be used interchangeably as conditional stimuli and by succeeding in manipulating the stimulus-response curves for x ray detection by introducing water vapor into the box. In the latter case the water vapor decreased detection efficiency, presumably by catalytically recombining atomic oxygen to O_2. Since this effect occurred in a gaseous medium (the air in the nasal passages), it provided evidence that the x ray detection was by way of a gaseous odorant rather than by direct action in the sensory cell. (auth)

28626 (NYO-2147-13, pp 193-5) SPINAL CORD: MODIFICATION OF ITS LABILE ELECTRICAL CHARACTERISTICS BY X-IRRADIATION. Gasteiger, E. L. (New York State Veterinary Coll., Ithaca. Dept. of Physical Biology).

Despite numerous studies of acute responses of the spinal cord to ionizing radiation, few have involved the more plastic or labile mechanisms of the cord. When looking for subtle responses to low level irradiation (less than 500 R) that might account for behavioral effects, it is desirable to examine neural systems susceptible to plastic changes. The spinal cord was excited repeatedly with single shocks given once per $3\frac{1}{2}$, 5, or 8 seconds over long periods of time. In this way plastic elements of the cord reach a new state of decreased or increased excitability. The cord was then irradiated and alteration of the new state was sought. (auth)

28627 (NYO-2147-13, pp 196-225) STUDIES ON RADIATION-INDUCED GUSTATORY AVOIDANCE BEHAVIOR. Tapper, D. N. (New York State Veterinary Coll., Ithaca. Dept. of Physical Biology).

Development of avoidance was found to occur as early as 14 minutes after the start of exposure (200 R at 80 R/minute ^{137}Cs gamma). When such fluid presentation scheme parameters as cycle time and initiation time after exposure were varied it was found that the number of presentations (onset score) was the most invariant measure. Doses ranging from 50 to 200 R had little effect on onset score. Development of avoidance must be clearly distinguished from strength of established avoidance. While a clear and rapid development was obtained when the fluid presentations scheme was initiated 90 and 180 minutes after the start of exposure, little or no evidence of conditioned avoidance was established. The strongest conditioning was obtained when the presentation scheme was initiated 20 minutes after the start of exposure. Onset score was also markedly influenced by the chemical cue used. At highly preferred concentrations of d,l-alanine significantly greater numbers of fluid offerings than with sodium saccharin were needed before development started. Similar results were found with NaCl and glycine solutions. Substrain differences in terms of efficacy of establishing the avoidance and of onset scores were found. (auth)

28628 (ORNL-4100) BIOLOGY DIVISION SEMIANNUAL PROGRESS REPORT FOR PERIOD ENDING JANUARY 31, 1967. (Oak Ridge National Lab., Tenn.). June 1967. Contract W-7405-eng-26. 218p. Dep. CFSTI.

Separate abstracts are prepared on the 23 different sections included in this progress report. (E.R.B.)

For abstracts of individual sections see: 28283–28289, 28399–28406, 28541, 28629, 28630, and 30411–30415.

28629 (ORNL-4100, pp 104-9) RADIATION IMMUNOLOGY. (Oak Ridge National Lab., Tenn.).

CELLS—immune reactions in cultured spleen; generation time in blast, in mice; mitotic generation time of cultured spleen cells, use of colchicine to determine; synthesis of antibodies by diffusion chamber cultured lymphoid; uptake of carbon-14-labeled amino acids by gamma globulin in cultured spleen; radiation effects on synthesis of antibodies by cultured spleen, x

MICE—radiation effects on life span of, x; radiation effects on immune reactions in; effects of human gamma globulin on immune reactions in; production of erythrocytes by fetal yolk sac in

ANTIBODIES—purification of, use of immunoabsorbents for

X RADIATION—effects on RNA metabolism in PHA-transformed lymphocytes (E.R.B.)

28630 (ORNL-4100, pp 118-26) MAMMALIAN RECOVERY. (Oak Ridge National Lab., Tenn.).

MICE—radiation effects on mortality of, effects of bone marrow transplants and hypoxia on x; radiation effects on respiration of, following uptake of carbon-14-labeled serine, x; radiation effects on content of intestinal protozoa in, x; iron-59 uptake by erythrocytes and spleen of effects of age and sex on; radiation effects on erythropoiesis in, following injection of spleen cells, x; production of pathogen-free inbred, design of facility for; incidence of virus infections in germ free and conventional; isolation of Salmonella poona from laboratory (E.R.B.)

28631 RADIATION TREATMENT OF CARCINOMA OF THE ESOPHAGUS. Barth, Gunther; Kern, W. (Univ., Giessen, Ger.). Throaxchir. Vask. Chir., 12: 57-68(July 1964). (In German).

The incidence of esophageal perforations following treatment of esophageal carcinoma by ^{60}Co irradiation and by high-energy electrons was reviewed. Out of 54 patients treated with 22 MeV electrons, with focal doses from 2000 to 7000 R, seven developed perforations. Out of 94 patients treated with 2000 to 9000 R of 31 MeV electrons eight developed perforations. The interval between start of the irradiation and perforation ranged from two to 31 months. When ^{60}Co irradiation was administered, the ratio of perforations observed to patients treated varied considerably with the dose. After treatment with 6000 to 6500 R, seven out of 98 patients developed perforations in from six weeks to 12 months. After 2800 or 9000 R two out of 18 developed perforations within eight months. After 7000 R two out of 19 also developed perforations. When 9000 R was given in two series to ten patients one perforation was observed after 18 months. Out of 68 patients irradiated with 5000 R each, perforations developed in ten within the period of one to ten months. (BBB)

28632 INJURIOUS EFFECT OF PANCREATIC SECRETIONS ON POSTRADIATION ENTEROPATHY. Morgenstern, Leon; Hiatt, Nathan (Cedars-Sinai Medical Center, Los Angeles, Calif.). Gastroenterology, 53: 923-9(Dec. 1967).

Attempts were made to determine which of the ingredients of the intestinal contents was responsible for the severe mucosal changes seen after acute radiation injury of the small intestine. Five to six days after the operation each dog was x irradiated over the abdomen, between the level of the tenth costal cartilage and the symphysis pubis, with an average tissue dose of 1500 R to the intestine. Clinically, the animals behaved exactly as control animals given 1500 R to the abdomen. After a latent period of 24 to 36 hr, vomiting and diarrhea began. At autopsy, the differences between the various segments of irradiated small intestine were striking. Small intestine, in contact with pancreatic secretion and its own intrinsic secretion (pylorus to entry of Roux-en-Y loop), revealed a reddened and edematous mucosa, with scattered small focal ulcerations. Recent hemorrhage was apparent by shreds of mucosanguineous material adhering to the damaged mucous membrane. Microscopically, severe radiation damage was seen in the mucosa. Small intestine, in contact with pancreatic juice, bile, and its own intrinsic secretion (entry of Roux-en-Y loop to ileocecal valve), revealed gross and microscopic characteristics identical with those described above. In small intestine, in contact with bile and its own intrinsic secretion (Roux-en-Y cholecystojejunostomy), the marked changes presented in the two previously described segments were absent. There was no edema, hemorrhage, or focal ulceration. Microscopically, the villi were of normal size and shape, with little or no denudation of the surface mucosal epithelium. Radiation damage, however, could be seen in both the surface and crypt epithelium as changes in nuclear and cellular architecture. Small intestine containing its own intrinsic secretion alone (Thiry-Vella fistula) also appeared unchanged. The results confirmed previous observations that a component of intestinal content was responsible for the aggravation of postradiation enteropathy. Evidently pancreatic juice was the element in small intestinal content that was chiefly responsible for the lethal effects of radioinduced enteropathy. If methods were developed either to divert or to neutralize the injurious element in pancreatic secretion, the lethality of large doses of radiation, administered either by accident or for therapy, should be considerably diminished. (BBB)

28633 THE MECHANISM OF RADIATION ACTION IN LEUKEMOGENESIS. ISOLATION OF A LEUKEMOGENIC FILTRABLE AGENT FROM TISSUES OF IRRADIATED AND NORMAL C57BL MICE. Haran-Ghera, Nechama; Peled, Alpha (Weizmann Inst. of Science, Rehovoth, Israel). Brit. J. Cancer, 21: 730-8 (Dec. 1967).

A leukemogenic agent was demonstrated in nonleukemic tissues of x-irradiated and normal C57Bl mice. Filtrates prepared from pooled tissues (thymus, bone marrow, spleen, and brain) removed from irradiated donors (four weekly 170 R whole-body doses) seven days following irradiation showed 25% leukemogenic activity; those removed 15, 30, and 60 days following irradiation, and from normal nonirradiated controls, gave only borderline activity. When thymus, bone marrow, mesenteric lymph nodes, spleen, and plasma were tested separately for the active leukemogenic agent, no activity was demonstrable in the tissues removed from donors two days following irradiation, whereas after seven days, the bone marrow filtrate showed 23% leukemogenic activity. The other filtrates tested were negative. The filtrate from normal thymus of young donors showed 10% leukemogenic activity, while the thymus filtrate from 400-day-old donors induced lymphomas in 17% of the inoculated mice. Bone marrow filtrates from young donors were slightly active (6%), while leukemogenic activity in filtrates from mesenteric lumph nodes was demonstrable only in old mice (12%). A possible factor contributing to the agent-release phenomenon demonstrable for a limited time could be the transient depression of immunologic responsiveness induced by irradiation. Tests on the immunological reactivity of irradiated mice were performed by evaluating the production of antibodies to Shigella antigen. The four weekly doses of 170 R whole-body exposure, used for leukemia induction, resulted in marked immunologic depression, the minimal antibody production in these mice persisting for about one week following irradiation, and coinciding with the timing of the demonstration of agent release. It was proposed that the degree of immunological depression of the host could be involved in the amount of agent released. (BBB)

28634 SKIN CARCINOMA FOLLOWING THE WEARING OF A RADIUM COMPRESS FOR BRONCHIAL ASTHMA. Theiss, Brigitte (Univ., Heidelberg). Med. Welt, No. 51, 2869-72 (Dec. 18, 1965). (In German).

Details are given of a case of squamous cell carcinoma observed in a 28-yr-old patient who had worn a Ra compress intermittently for four yrs for treatment of asthma. The area covered by the compress was 20 × 25 cm^2, and showed hyperpigmentation, depigmentation, teleangiectases, atrophic areas, numerous hyperkeratoses, and an ulcerated area. Adjacent cartilaginous areas of the rib cage were calcified, portions of the lung and pleura were involved, and some symptoms of respiratory distress were apparent. The tumor was removed surgically, and later removal of the entire irradiation-damaged tissues was planned. The Ra compress was found to contain 0.2 mg of Ra. The dose from the compress was irregularly distributed over its total area and volume. Immediately at the surface the dose was 1600 mrep/hr, and at 1, 2, and 4 mm depth the doses were 400, 210, and 84 mrep/hr. It was estimated that the patient received about 400 R/yr, or 1600 R during the four yrs that the compress was used. Previous reports indicate that tumors may be induced by doses greater than 1000 R. (BBB)

28635 CLINICAL TRIAL OF DIFFERENT DOSES OF ^{131}I IN TREATMENT OF THYROTOXICOSIS. Smith, R. N.; Wilson, G. M. (Royal Infirmary, Sheffield, Eng.). Brit. Med. J., 1: 129-32(Jan. 21, 1967).

The main disadvantage in the treatment of thyrotoxicosis with ^{131}I was a high incidence of hypothyroidism, which rose steadily with time. A preliminary trial suggested that the incidence was related to the dose. A definitive trial was carried out in which thyrotoxic patients were allotted at random to 2 treatment groups. The first group, containing 276 patients, received a conventional dose of ^{131}I, 140 μCi/g of thyroid tissue, delivering about 7000 rad. The second group (270 patients) received half this amount. Only a single dose of ^{131}I was given. Thereafter, if the thyro-

toxicosis did not remit satisfactorily, antithyroid drugs were given; this was required in 43% of the patients receiving the conventional dose and in 64% receiving the half dose. The antithyroid drugs were tailed off as the effect of ^{131}I became apparent. The patients were not regarded as euthyroid as a result of ^{131}I unless they had been off the drugs for at least six months. Incidence of hypothyroidism rose steadily in the conventional-dose group from 8% after one yr to 29% after five yrs. In the half-dose group it was reduced to 4% and 7% at the corresponding intervals. The advantages of treating thyrotoxicosis with a small dose of ^{131}I, followed when necessary by antithyroid drug therapy, were discussed. (BBB)

28636 NEW INDUCED TRANSPLANTABLE RAT MAMMARY CARCINOMA. Engle, G. Caroline; Spencer, G. R. (Washington State Univ., Pullman). Amer. J. Vet. Res., 128: 1851-6(Nov. 1967).

A mammary adenocarcinoma was induced in Northwest Sprague-Dawley rats by x irradiation. It was transplanted through 35 generations over a period of 17 months. The tumor was regularly fatal in both males and females after the 2nd transplant generation. It was highly anaplastic and was composed of two main cell types. Large, pleomorphic epithelial cells predominated in some areas, whereas in other sections the principal type was spindle-shaped cells. Transplanted tumors grew rapidly and were invasive but rarely metastasized. They usually killed the host in 15 to 35 days. Subcutaneous, intramuscular, and intraperitoneal routes were successful for transplants. Strain specificity was minimal, tumor growth being progressive in Sprague-Dawley, Northwest Sprague-Dawley, Holtzman, and Wistar rats; the tumor grew in Long-Evans rats but later regressed. (auth)

28637 STUDIES ON THE DYNAMIC PROCESSES IN THE OVUM OF THE SPIDER CUPIENNIUS SALEI (CTENIDAE) BY MEANS OF X-RAY BARRIERS. Seitz, Karl-August (Philipps-Univ., Marburg-Lahn, Ger.). Zool. Jahrb., Abt. Anat. Ontog. Tiere, 84: 343-74(1967). (In German).

Local high-dose x irradiation of selected zones of spider eggs was used to study various developmental processes. A zone 400-μm wide received a dose of 4650 R. A band of reversible contractions occurred around the egg in the irradiated area. The consistency of the yolk was changed irreversibly, and some injured cells disappeared into the yolk. Normal cells of adjoining nonirradiated regions penetrated into the damaged zone and initiated recovery. Such x-ray-induced barriers (up to 4650 R) did not impede normal developmental processes. Therefore, cells coagulated by x rays could be used as markers to follow normal morphogenetic stages. Transverse barriers were induced by irradiation of the zone between presumptive prosomal and opisthosomal areas. With the beginning of cell congregation, the cells moved in a caudal direction and approached the primitive plug, but did not penetrate into the center. The congregating cells reversed the direction of their movement as soon as the cumulus migration started. Experiments were also done with median barriers, crossing the primitive plate or the primitive plug and separating left and right germ-band ridges. A streak of coagulated cells enclosed the germ hemisphere six hours after irradiation and in the further course of development extended around the whole egg. The different sensitivity of presumptive prosomal and opisthosomal cells to x rays, as well as anterior-posterior movement, caused the barrier to form a ring around the egg several hours later. In the state of the segmented germ-band, coagulated cells were found in the borderline between embryonic and extraembryonic material. (BBB)

28638 A COMPARISON OF THE EFFECTS UPON HeLa CELLS OF ISOPROPYL METHANE SULPHONATE AND X RAYS DURING DIFFERENT PHASES OF THE CELL CYCLE. Petrovic, Danilo; Nias, A. H. W. (Christie Hospital, Manchester, Eng. Holt Radium Inst., Manchester, Eng.). Eur. J. Cancer, 3: 321-8(Nov. 1967).

The effects on HeLa cells of the alkylating agent isopropyl methane sulfonate (IMS) and x irradiation were compared. Survival of the clone forming ability of asynchronous cells followed a similar dose-response curve after both agents, and there was a similar effect upon the distribution of clone sizes. By contrast, treatment at different times during the cycle of synchronized cells revealed a marked difference in survival patterns: after irradiation the level of survival varied and the G_1–S transition period was much more radiosensitive than the rest of the cell cycle. Treatment with IMS produced no difference in survival level throughout the majority of the cell cycle. A different mode of action was postulated for the two agents. (auth)

28639 LARGE INTESTINE CARCINOMA AFTER RADIUM THERAPY OF THE FEMALE GENITAL ORGANS. Yasargil, E. C.; Bregulla, K. G. (Chirurgische Univ., Basel). Helv. Chir. Acta, 34: 399-405(Oct. 1967).

The development and characteristics of large intestine carcinoma in two patients who were irradiated, in the first case for an ovarian tumor with 11,200 R of x radiation and 5740 mg-hr of Ra, and in the second case with 12,000 R of x irradiation and 8000 mg-hr of Ra, are presented and discussed. The treatments were given for 15 and three yr, respectively, prior to the detection of the large intestine carcinoma. These were located in the immediate vicinity of the previously irradiated organs. The tumors had histological structures that were different from the original genital carcinomas, so that they could not be considered late recurrences or metastases. The independence of the large intestine carcinomas was also suggested by evidence from other reports. The possible effects of the x-ray treatments on the development of the intestinal tract carcinomas were discussed. Many chronic inflammatory intestinal wall changes produced by irradiation of the female genital organs developed at the level of the promontorium or in the tissues located deeper. These could cause intestinal constriction, stenoses, and hemorrhages. The intestinal carcinomas here reported developed at the rectosigmoid and rectal areas, and at the level of the body of the uterus. (BBB)

28640 EFFECTS OF X RAYS ON THE MATURING NERVOUS SYSTEM: FURTHER STUDIES WITH A PRELIMINARY STUDY OF VASCULAR ALTERATIONS. Gilmore, Shirley Ann; Arrington, Robert W. (Univ. of Arkansas Medical Center, Little Rock). Neurology, 17: 1059-67(Nov. 1967).

Histopathologic changes were examined nine to 21 days after a single dose (4000 R) of soft x rays to a localized portion of spinal cords in three-day-old rats. Through Day 13 postirradiation, the major changes were a decrease in number of neuroglia and of vessels. Many vessels were dilated and the endothelium hypertrophied. Perivascular globules, isolated or in clumps, were noted frequently. Some neurons had degenerative changes, but the incidence of these was infrequent. From 15 through 21 days following irradiation, the changes in blood vessels increased in severity. Necrosis developed in both gray and white matter. The irradiated vertebrae did not develop normally and appeared to impinge upon the spinal cords in the rats killed toward the end of the experimental period. The results indicated that this dose of radiation would be unsuitable for long-term studies because it induced necrosis within 21 days. The significance of the changes, especially those in the vascular system, noted in this study were discussed with regard to changes observed at earlier postirradiation periods in previous studies. (BBB)

28641 SKIN CANCER AND THE SUN. Freeman, Robert G.; Knox, John M. (Baylor Univ., Houston, Tex.). CA - Cancer J. Clin., 17: 231-8(Sept.-Oct. 1967).

Carcinogenic and other effects of uv radiation on the skin were reviewed. Other results of sun exposure were erythema (sunburn), pigmentation, and changes leading to wrinkling, mottling of skin color, and degeneration of dermal connective tissue. The three commonly associated results of sun exposure (erythema, degeneration, and cancer) may be related. The wavelengths responsible for all three changes apparently lie in the same portion of the uv spectrum (290 to 320 mμ). The initial injury from sunlight exposure was described. At least three different structures in the skin were known to be altered by uv light. Skin cancers could be produced in mice by exposure to Hg arc lamps, sunlight, germicidal lamps, ionizing radiations, and monochromatic light of wavelengths of 250 mμ. Cancers did not develop if the radiation was filtered through window glass. Thus the action spectrum for skin cancer was in wavelengths shorter than 320 mμ, the cutoff point for window glass transmission. Any measures which diminished the solar spectrum between 290 and 320 mμ decreased the carcinogenic potentialities of sunlight. Topically applied creams and lotions could be used to prevent sunburn as well as to reduce the carcinogenic dose of the sun's rays. On the basis of present knowledge, only the mid-uv wavelengths needed to be filtered out to prevent cancer. More strenuous requirements for filtration might be required in other situations, such as patients with photosensitivity. Other measures for prevention of skin cancer were described. (BBB)

28642 RADIOINDUCED ASYMMETRY OF THE THYMUS IN MICE. Jaerplid, Bertil (Research Inst. of National Defence, Sundbyberg, Sweden). Acta Pathol. Microbiol. Scand., 70: 561-5 (1967).

The central role of thymus in radioinduced lymphoid tumors in mice has been established, and spontaneous and virus-induced thymus lymphoma may be preceded by a phase of lymphocyte depletion. To elucidate the genesis of radioinduced lymphoma, histological changes in the thymus after total-body x-ray exposure were systematically studied and analyzed from the time of irradiation up to the development of thymus lymphoma. C3H mice (293 males and 297 females, 25 days old) were irradiated with 500 R in four equal fractions at intervals of four days. Micro-

scopic findings revealed that an asymmetry of the lobes of the thymus, as to weight and histologic picture, began to appear during a secondary regenerative phase following irradiation. This asymmetry was observable for several months and seemed to be correlated with the occurrence of unilateral lymphomas. The second depletion of lymphocytes was followed by a phase of regeneration similar to the first occurring after irradiation. Immature lymphoid cells with a finer chromatin structure and basophilic cytoplasm formed successively a broad, mitosis-rich cortex, surrounding small, diffusely bordered medullary islands. Further development resulted in an apparently normal lobe of increased size and weight. In certain cases an abnormally broad cortex was seen in which medullary islands were absent or very small. Animals in another experiment were irradiated with 550 R as a single dose. As expected, fewer lymphomas were obtained but also fewer and less marked asymmetries than with fractionated irradiation. Since thigh shielding prevented the development of a secondary weight reduction in the thymus and inhibited radio-induced lymphoma, an experiment was conducted to ascertain the effect on the occurrence of the asymmetrical thymus. The left thigh was shielded during irradiation (550 R in four fractions). On the 25th day, the mean weight difference between the lobes of the thymus was 5.5% of the total weight, in the untreated control animals 6.3%, and in unshielded irradiated animals 27.5%. (BBB)

28643 OBSERVATIONS CONCERNING MUTATION TO COSMIC RADIATION. Eugster, J. pp 163-4 of Life in Space Craft. Vol. 7. Lunc, Michal (ed.). New York, Gordon and Breach, 1966.

Evaluation of observations concerning mutation of human tissue by cosmic radiation was carried out on male and female experimental subjects at an altitude of 3500 m. Histological preparations including over 800 serial slices revealed a direct relationship between the rate of cell differentiation and increased cosmic radiation. An interesting phenomenon was the observation of reverse mutation at various locations. These were centers of concentrated precancerous tissue, which, during the first stage of an incipient malignancy, correlated with the highest density of nuclear tissue. (IAA)

28644 AGEING IN IRRADIATED AND UNIRRADIATED GERMFREE ICR MICE. Walburg, H. E.; Cosgrove, G. E. (Oak Ridge National Lab., Tenn.). Exp. Gerontol., 2: 143-58 (1967). (ORNL-P-2932).

The life span and incidence of disease were studied in germfree, conventional, and barrier ICR mice which had not been exposed to x-irradiation and in germfree and conventional male mice of the same strain which had been exposed to 600–900 R of x radiation at 12 weeks of age. Unirradiated germfree mice had an increased survival rate in the middle one-third of the life span if those dying with cecal volvulus were omitted from the sample, but the difference disappeared in the last third of life. Irradiation of germfree mice resulted in life-shortening of approximately 275 days when mice dying of diseases other than thymic lymphoma and cecal volvulus were compared. The germfree mice resembled the mice raised in contaminated environments in the development of lymphatic leukemia, reticulum-cell sarcoma, and solid tumors of various sites. Glomerulosclerosis was observed in all groups of mice, but its incidence and severity were lower in unirradiated germfree mice. Irradiation of germfree male mice raised the severity of glomerulosclerosis to that seen in contaminated mice. Miscellaneous lesions common to conventional mice (i.e., amyloidosis, uterine hypertrophy and ovarian cysts) were seen in germfree mice, but inflammatory lesions associated with infectious microorganisms (such as otitis media, abscesses, and ulcerative dermatitis) were seen only in mice raised in microbially contaminated environments. Cecal volvulus and severe distention of the gall bladder were noted only in germfree mice. The general similarity of widely diverse pathological lesions between germfree and conventional mice suggests that the absence of a detectable microbial flora and fauna alters ageing processes and late somatic effects of radiation relatively little. (auth)

28645 BIOLOGICAL ACTION OF 120-MeV PROTONS. Moskalev, Yu. I.; Petrovich, I. K. Byull. Eksp. Biol. Med., 62: No. 12, 53-6(Dec. 1966). (In Russian).

The authors studied the effect on rats of a single exposure to 120 MeV protons in doses ranging from 10 to 1,000 rads. They found the LD_{50} for various periods (7 to 600 days), noting a correlation between the dose and time of death. An examination of the peripheral blood showed changes in the white blood cells indicative of neutropenia and lymphocytopenia followed by a neutrophil leukocytosis. The leukocyte count dropped sharply the first week after irradiation, after which it gradually returned to normal within 2 months. The number of erythrocytes decreased sharply after irradiation with doses of 700, 800 and 1,000 rads. The animals irradiated with 1,000 rads exhibited a 45% decrease in the count within 7 days. In the rats that survived doses of 700 and 800 rads, the erythrocyte count eventually returned to normal by the time they died (9 to 13 months). (JPRS)

28646 THE INFLUENCE OF A FRACTIONATED X IRRADIATION ON THE NAD CONTENT OF SOLID TUMORS AND THE HOST LIVER. Maass, H.; Hoelzel, F.; Trobisch, H. (Univ., Hamburg). Z. Krebsforsch., 70: 115-21(Nov. 11, 1967). (In German).

The metabolism of nicotinamide adenine dinucleotide (NAD) is usually altered by cytotoxic agents, such as cytostatic drugs, that decrease its content in tumor cells. Relatively high doses of ionizing radiation were found to cause a decrease of NAD in some cells, and attempts were made to demonstrate this effect at lower, fractionated doses of 200 kV x rays. After fractionated x irradiation of solid Ehrlich carcinoma with daily doses of 400 R, 2000 R total, no changes of tumor NAD content were observed. The dose used was sufficient for extensive regression of the tumors. In animals treated simultaneously during the radiation treatment with nicotinamide (10 mg) the radiation effect on tumor growth was nearly abolished. There was also a clear-cut increase in the transplantability of the tumors of the nicotinamide-treated animals as compared with the group only irradiated. In the livers of the tumor-bearing animals the NAD content was significantly reduced. As expected, the NAD content of the liver was elevated above the control values after nicotinamide treatment. An increase of the liver NAD of the same degree was observed in the animals in which the tumors were irradiated without use of nicotinamide. (BBB)

28647 PATHOGENESIS OF RADIATION-INDUCED ENDOCRINE TUMORS. Berdjis, C. C. (Army Experimental Medicine Dept., Army Edgewood Arsenal, Md.). Oncology, 21: 49-60(1967).

A relation existed between the cellular structure of endocrine tumors and their hormonal activity. An attempt was made to correlate the morphological characteristics and metabolic or hormonal disturbances in irradiated animals developing tumors. Sprague-Dawley 100-day-old rats received whole-body 250-kV x irradiation, either as 500 R in a single exposure or 3 × 350 R in six weeks. From the third month postirradiation, some rats of each group were sacrificed every three months over a period of 24 months. Representative sections of each organ and the entire endocrine system were histologically examined. The irradiated rats developed progressively a wide variety of tumors in practically all organs, especially in the endocrine glands. A few tumors occurred spontaneously in the aging controls. Irradiation had a predilection for endocrine organs with a distinct deleterious effect on the gonads. Since many animals were sacrificed under one year of age, the tumor incidence recorded here was lower than that reported in literature. The following percentages of tumors were found in control and irradiated rats, respectively, in various glands: pituitary 4, 13; thyroid 2.5, 17.5; parathyroid 0, 8; pancreas (islet cell tumors) 4, 15; adrenal 3, 13; testis 6, 35; and ovary 5, 33%. It appeared that atrophy, cellular degeneration, and/or degradation together with increased periodic acid-Schiff (PAS) positive material and precocious senescence created an abnormal situation resulting in bizarre or preneoplastic cells. These cells were probably responsible for neoplastic proliferation and production of endocrine tumors. It was suggested that radio-induced genetic factors can influence the induction of endocrine tumors. (BBB)

28648 PHARMACOLOGICAL STUDIES ON CHEMICAL PROTECTORS AGAINST RADIATION. I. RADIOSENSITIVITIES OF MICE AGAINST X IRRADIATION. Shinoda, Masato; Oka, Takami (National Inst. of Radiological Sciences, Chiba, Japan). Yakugaku Zasshi, 87: 654-7(June 1967). (In Japanese).

In order to establish the potency test for chemical radiation protectors, radiosensitivity of various strains of mice to x irradiation was examined. The mice used were ddY, CF_1 and CRF_1 strains, and it was found that the survival rate 30 days after irradiation and the mean survival time were both effective indices of radiation injury. Since the variation in radiation dosage, and the strain and age of mice affected the radiosensitivity, optimum conditions for biological assay of chemical radiation protectors were determined as follows. When using ddY strain mice, those of four to seven weeks of age should be used and given x irradiation of 700 R. With CRF_1 strain mice, 600 R dose seems to be appropriate. In the case of CF_1 strain mice, radiation dosage and variation in survival rate failed to show linearity and this strain of mice is considered to be unsuitable for this biological assay. (NSA of Japan)

28649 DIARRHEIC SYMPTOMATOLOGY DURING RADIOTHERAPEUTIC TREATMENT ON THE ABDOMEN. PHOTOFLUOROGRAPHIC ASPECTS. De Marzi, S.; Aulisi, A. (Univ., Florence). Nunt. Radiol., 32: 741-56(Aug. 1966). (In Italian).

The physiology of the human gastrointestinal tract during the onset of diarrhea developed during x radiation treatment of the abdomen was examined by means of photofluorography. A delay in the gastric emptying, frequent dystonia, acceleration of the passage of food into the small intestine, and, in a high percentage of cases, acceleration of the passage into the colon were observed. In some patients the examination was repeated after administration of drugs, when a normalization of the passage times was then observed. (tr-auth) (TSS)

28650 EVALUATION OF THE MODIFICATION OF THE INTESTINAL ABSORPTION OF SOME CARBOHYDRATES IN PATIENTS IRRADIATED ON THE ABDOMEN. Giannardi, G. F.; De Marzi, S.; Renzi, R.; Boddi-Giannardi, G. (Univ., Florence). Nunt. Radiol., 32: 723-30(Aug. 1966). (In Italian).

The metabolism of glucosides was studied in cancer patients x irradiated with 3000 to 5000 rad. Results of tolerance tests for glucose and sucrose were compared with results of the xylosuria test. The studies confirmed a decrease of xylosuria at the end of the radiation treatment. Results also showed a correlation in the results of the tolerance tests. It was concluded that irradiation caused the impairment of the passive absorption both for glucose and the metabolic products of sucrose. (tr-auth)

28651 SYSTEMATIC ARTERIAL PRESSURE OF TUMOR BEARERS IN THE INITIAL PHASE OF EXPOSURE TO IONIZING RADIATION. Bompiani, C.; Falcetti, E.; Matronola, V.; Paleani-Vettori, P. G. (Univ., Rome). Nunt. Radiol., 32: 711-22 (Aug. 1966). (In Italian).

The behavior of the systemic arterial blood pressure of tumor patients during exposure to doses of 150 to 300 rad γ radiation was studied. Changes were observed both in the maximum and minimum pressure values in 85% of the patients examined. The irradiation of the latero-cervical region of the thorax, and of the upper quadrants of the abdomen caused, in most cases, a decrease of blood pressure. Irradiation of the pelvic cavity induced an increase of pressure. The totality of the changes observed was, on an average, 28 mm Hg for the maximum and 18 mm Hg for the minimum pressure. (tr-auth) (TSS)

28652 THE METAMERISM OF THE SPINAL PTERYLA, STUDIED IN CHICKEN EMBRYO WITH LOCALIZED X IRRADIATION. Sengel, Philippe; Mauger, Annick (Faculte des Sciences, Grenoble, France). Compt. Rend., Ser. D, 265: 919-22(Sept. 25, 1967). (In French).

The dorsal tegument of chick embryos in various stages of development was x-irradiated. Following irradiation, the arrangement of feathers was compared to that of a normal embryo of 11 days. The irradiation resulted in non-differentiation of a transverse section of the spinal pteryla; evidence of this was a lateral denuded area. Results of the study demonstrated that the arrangement of feathers corresponded to somatic metamerism. (H.L.W.)

28653 CHANGES IN THE ERYTHROPOIETIN-RESPONSIVE CELL AFTER EXPOSURE TO IRRADIATION. Hodgson, George; Eskuche, Irma (Univ. de Chile, Santiago). Ann. N. Y. Acad. Sci., 149: 230-5(Mar. 29, 1968).

The effects of doses of 100 to 200 R γ of x radiation on the erythropoietin response of erythroid cells in bone marrow of fasted rats were studied. Results indicated that the stage of mitosis at the time of irradiation had an effect on response to erythropoietin. The effects of actinomycin D and colchicine on the response of erythroid cells to erythropoietin during the cell cycle were also studied. Results indicated that stem cells became responsive to erythropoietin shortly after undergoing mitosis, and that during this stage they became relatively radioresistant. This period lasted about eight hr, after which the proerythroblasts entered a radiosensitive phase prior to cell division. (C.H.)

28654 HUMORAL EFFECTS ON MARROW CELL DIFFERENTIATION. Korst, Donald R.; Quirk, Janet (Madison General Hospital, Wis. Univ. of Wisconsin, Madison). Ann. N. Y. Acad. Sci., 149: 236-48(Mar. 29, 1968).

Studies on stem cell differentiation or spleen colony differentiation in x-irradiated syngeneic marrow-transplanted mice suggested that the primary effect of humoral regulation is at the stem cell level. This primary stimulus appeared to provide more stem cells that were randomly differentiated depending on humoral regulation; a secondary effect of the stimulus may be to accelerate an increased production along normal pathways, perhaps by shortened cell cycles. The effects of erythropoietin on the development of erythrocytes was studied. (C.H.)

28655 EFFECT OF ADRENALECTOMY ON THE EXCRETION OF THYMIDINE AND DEOXYURIDINE BY γ- IRRADIATED RATS. Skurikhina, M. M.; Lemova, M. A. Radiobiologiya, 7: 478-9(1967). (In Russian).

It was established that adrenalectomy increased the level of deoxycytidine in urine, of irradiated rats. The same relation was found to apply to excretion of thymidine and deoxyuridine in the urine. On irradiation of rats with γ-rays at a dose of 800 R, the excretion of these nucleosides was approximately twice as great for adrenalectomized rats as for irradiated control rats. Special experiments indicated that adrenalectomy did not increase the level of thymidine or deoxyuridine in urine. (JPRS)

28656 EFFECT OF EXPOSURE CONDITIONS ON THE PRODUCTION OF RADIATION LESIONS IN RAT SMALL INTESTINE. Jervis, Helen R.; Donati, Robert M.; Stromberg, LaWayne R.; Sprinz, Helmuth (Walter Reed Army Medical Center, Washington, D. C.). Proc. Soc. Exp. Biol. Med., 127: 948-52(Mar. 1968).

X irradiation (2000 R) of small gut of the rat in general produces a shortening of the viscus which is time dependent. This dose, when delivered either to the whole-body or to the abdomen only, produces in the small gut of the rat the uniform classic lesion of the acute intestinal radiation syndrome, but without generalized denudation. The characteristic, foamy, epithelial cells that line most of the luminal surface after the third day are packed with large lipid droplets. The same dose, when applied to the exteriorized gut produces patchy lesions with areas similar to the above, interspersed with apparently intact areas usually concentrated in the upper small intestine. There are indications that the intact areas might have escaped the full effect of the dose delivered due to some interference with their blood supply resulting from the process of exteriorization. (auth)

28657 ABOUT THE DISTURBANCE OF DEVELOPMENTAL DYNAMICS OF COLLATERAL LYMPH-CIRCULATION FOLLOWING LOCAL X-IRRADIATION WITH DIFFERENT DOSES. Pozarisskaja, T. D. (Leningrad Medical Inst.). Radiobiol.-Radiother., 8: 485-96(1967). (In German).

The development of collateral lymph circulation after an excision of the popliteal lymph node in 88 rabbits under the conditions of a local single irradiation with doses of 3000 R, 15000 R, and 500 R was investigated in this work. These irradiations were shown to cause radical changes in the development of lymph circulation the extent and character of which depends on radiation dose. (auth)

28658 AGE DIFFERENCES IN THE RADIOSENSITIVITY OF RATS AND THEIR RELATIONSHIP TO URINARY EXCRETION OF 5-HYDROXYINDOLEACETIC ACID. Taceva, J.; Pospisil, M. (Inst. of Biophysics, Brno). Radiobiol.-Radiother., 8: 541-6(1967).

Previous evidence of the favorable prognostic significance of higher post-irradiation excretion of 5-hydroxyindoleacetic acid (5-HIAA), was verified by studying the interindividual differences in the radiosensitivity of rats in a homogeneous age group and the differences of radiosensitivity manifesting themselves during irradiation of animals of two age intervals of four and ten weeks. In either case a higher variance of the post-irradiation 5-HIAA excretion values was found in the more sensitive animals, testifying to the unfavorable prognostic significance of extreme variances of interindividual fluctuation of 5-HIAA excretion. Similar results were also obtained in the evaluation of the individual differences in intraindividual post-irradiation variability of this function. The unfavorable prognostic significance of low and high variances of intraindividual fluctuation of 5-HIAA excretion was described. The results can be explained only by the unbalanced participation of serotonin metabolism in the compensating, homeostatic mechanism, activated in post-irradiation syndrome. (auth)

28659 LATE SPINAL DAMAGE CAUSED BY THOROTRAST MYELOGRAPHY IN DOGS. A STUDY ON THE EFFECT OF LONG-TERM ALPHA IRRADIATION ON THE CENTRAL NERVOUS SYSTEM. Hansen, H. J. (National Inst. of Veterinary Medicine, Stockholm). Schweiz. Arch. Tierheilk., 108: 351-67(July 1966). (In German).

After a review of the literature concerning tissue injury from Thorotrast, case reports and histologic finding for eight dogs that were subjected to myelography were described. Seven of them showed neurological symptoms as a result of damage from Thorotrast. The interval between the injection and the appearance of the symptoms was between $3\frac{1}{2}$ and seven yr. Two types of lesions were prominent: Damage to the blood vessels, with proliferative and degenerative changes in the walls, followed by homogenizing degeneration and proliferative reactions of the mesenchymal elements of the leptomeninges and the endoneurium. After a discussion of the literature concerning the effect of ionizing radiations on the central nervous system, the present findings were discussed. The conclusion was reached that a direct degenerative or proliferative reaction of the neuroectodermal compo-

nents to irradiation could not be proven. The observed destruction of nerve tissue might more readily be explained by the changes in the blood vessels, or by the disturbances in blood supply caused by them. The Thorotrast phenomenon was unique in that it constituted (although unintentionally) an experiment of very long duration with a low dosage of radiation per unit of time. (BBB)

28660 THE COMBINED EFFECT OF HYDROXYUREA AND X-RAYS ON CHINESE HAMSTER CELLS IN VITRO. Sinclair, Warren K. (Argonne National Lab., Ill.). Cancer Res., 28: 198-206(Feb. 1968).

Hydroxyurea inhibits DNA synthesis in Chinese hamster cells and is selectively toxic for cells actually in DNA synthesis (i.e., in S phase) at the time of exposure to the drug. Synchronized cells in G_1 inhibited from entering S by hydroxyurea show a complex response to x radiation. Cells become steadily more sensitive for a period of about 4 hr and then recover about a normal G_1 sensitivity in approximately a further 4 hr. They never achieve the high survival level normally found for uninhibited cells in late S, but they will reach this level quite rapidly if the hydroxyurea is removed prior to exposure. The sensitization, is therefore, completely reversible. Hydroxyurea has no effect if present only during exposure at room temperature. Additional sensitization is obtained if the drug is present after exposure that increases for a period of about 4 hr. This postirradiation sensitization is independent of the time in the cycle at which irradiation takes place. These results with synchronized populations enable the effects of hydroxyurea on asynchronous populations to be predicted. The most sensitive condition occurs when irradiation is given about 4 hr after the administration of hydroxyurea and the drug is kept on subsequently. The results indicate that hydroxyurea in combination with x rays can be most effective toxic agent for Chinese hamster cells. If these results are applicable to in vivo situations, combination therapy with hydroxyurea given systematically and x rays delivered locally to tumors may be most effective. However, in view of some of the problems in tumor control that cannot be evaluated in vitro, experiments with suitable animal tumor systems are needed. (auth)

28661 THE INFLUENCE OF WHOLE-BODY EXPOSURE TO X-RAYS OR NEUTRONS ON THE LIFE SPAN DISTRIBUTION OF TUMORS AMONG MALE RATS. Castanera, T. J.; Jones, D. C.; Kimeldorf, D. J.; Rosen, V. J. (Naval Radiological Defense Lab., San Francisco). Cancer Res., 28: 170-82(Feb. 1968).

Adult male rats were irradiated with single, whole-body doses of x rays (430 or 680 rads) or with fast neutrons (230 or 320 rads) and maintained in a duration-of-life study. An analysis of the extent of tumorigenesis was made according to the type of tumor, the number of animals with tumors, and the distribution of tumors among organs for each dose group. Greater proportions of the irradiated groups developed greater numbers of tumors than did the controls, even though lifespan was reduced by irradiation. Radiation was particularly effective in inducing malignant tumors of epithelial origin although there were significant excesses of animals with malignant nonepithelial tumors and with benign tumors of both epithelial and nonepithelial origin. Among the numerous organs and tissues in which tumors developed, the skin, kidney, lung, and islets of Langerhans appeared especially responsive to irradiation. Consistent relationships between incidences of animals with tumors and dose or quality of radiation were not apparent. (auth)

28662 RADIOBIOLOGICAL CELL SURVIVAL DATA AND THE PRINCIPLES OF RADIATION DOSIMETRY. Sullivan, A. H. (CERN, Geneva). Health Phys., 14: 299-305(Apr. 1968).

A theory of cell survival is developed to obtain the relation $-\ln S = N(e^{-aD} + bD - 1)$ for the surviving fraction of cells S at a dose D. Numerical values of N, a and b are deduced for a set of cell survival data, and it is suggested that N is a function of the cell species and the biological tests made, and that the ratio b/a is a function of the radiation. A model of radiation interaction is discussed from which it is deduced that a measurement of the frequency with which the ion density exceeds some threshold will be proportional to the radiation damage, independent of the type of radiation. Analysis of cell survival data suggests that this threshold occurs when two ions are produced within a distance of the order of 30 Å in tissue. (auth) (UK)

28663 THE EFFECT OF FRACTIONATED X-RAYS AND γ-RAYS ON THE TADPOLE OF AMPHIBIA. 2. ON THE RHACOPHORUS SCHLEGELII ARBOREA. Tanaka, Norimoto (Kyoto Prefecture Univ.). Nippon Igaku Hoshasen Gakkai Zasshi, 26: 914-21(Oct. 1966). (In Japanese).

The effect of fractionated x ray and γ ray irradiations was studied on the survival response of Rhacophorus tadpoles. Materials in the experiment were obtained near the university as an egg block and Rhacophorus schlegelii arborea tadpoles, 12 to 23 mm, from the same egg block were used. The change in the dose-rate in single dose exposures does not give any difference. There is no difference in survival response between the fractionated exposure and the single-dose irradiation. Fractionated irradiations with x- and γ-rays tended to decrease radiosensitivity, compared with the single dose irradiation, although it depends somewhat on the body length, environmental temperature after irradiation, etc. The effect of fractionated irradiations was influenced by the time interval and number of fractions. The difference in the fractionated irradiation effects between the Rhacophorus schlegelii arborea and Rana nigromaculata were described to the particular biological species, physiology, development, and ecology. (NSA of Japan)

28664 STIMULATIVE EFFECT OF SMALL DOSES OF GAMMA RADIATION ON CHICK EMBRYO DEVELOPMENT. Shao, Wei (Kirin Normal Univ., China). Chung Kuo Hsu Mu Shou I, No. 7, 19-20(July 1962). (In Chinese).

This article reviews the foreign literature and summarizes the effect of small doses of γ radiation on increased productivity in domestic fowl. The stimulative effect of small doses of γ radiation (0.01–2.9 R) on chick embryo development and post embryonic growth is noted in greater embryo viability, hatching rate and egg productivity of hens over the control group. (JPRS)

28665 STUDIES ON THE KINETICS OF MARROW REGENERATION AFTER LOCAL IRRADIATION OF THE FEMUR IN RABBITS. Murdock, David K.; Ramsby, Gale R.; Kligerman, Morton M.; Calabresi, Paul (Yale Univ., New Haven). Cancer Res., 28: 304-8(Feb. 1968).

The development of two laboratory techniques for more accurate quantification of hematopoietic activity, radioactive iron (^{59}Fe) uptake and DNA content of marrow cells, are described, utilizing a regenerating marrow system in rabbits after local x irradiation of 1 femur while shielding the contralateral leg. The sensitivity and reproducibility of the two methods were determined: there was good correlation of the results obtained with these two techniques. The significance of these tests of bone marrow activity as useful indicators in the experimental evaluation of new myelosuppressive agents is discussed. (auth)

28666 DOSAGE PROBLEMS IN RADIATION INJURIES IN MAN. Schulte-Brinkmann, Wolfgang (Univ., Duesseldorf). Med. Welt, No. 30, 1567-75(July 23, 1966). (In German).

The problems of irradiation injuries, including genetic injuries, somatic irradiation injuries, and occupational irradiation injuries were discussed. The evidence presented indicated that the average gonadal dose for an entire population probably was more important genetically than the question of above average gonadal exposure of individuals. It was a relatively minor factor to produce malformations within the first few generations, at least. Irradiation of persons with malignant tumors was associated with some risk of somatic injuries, even under the best conditions. In treatment of nonmalignant diseases, there was no cause for somatic irradiation injuries, particularly if the doses used were held to only a few R of whole-body irradiation, or to only a few hundred R for localized irradiation, and special precautions were taken to limit irradiation to children, who have a high radiosensitivity. Present-day dose levels used in irradiation diagnostic studies were low, but precautions to prevent excessive gonadal exposure were necessary. Occupational irradiation exposures were consistently low, so that the hazards were no greater than in other medical fields. References cited, 52. (BBB)

28667 LIVER FUNCTION OF RATS AFTER CHRONIC FEEDING OF ^{90}Sr. Czok, G.; Lang, K. (Univ., Mainz). Z. Ernaehrungswiss., 7: 65-8(1966). (In German).

After chronic feeding of 140 or 350 pCi/g Ca of ^{90}Sr to rats, liver excretion of bromsulfonphthalein was slightly decreased. This effect was greater at the higher level of ^{90}Sr administration and after longer periods of administration, which ranged from 39 to 104 weeks. The differences observed, which amounted to a doubling of the average retention in control animals, were insufficient to indicate that liver function in the animals was markedly impaired by the irradiation received from deposited ^{90}Sr or its daughter, ^{90}Y. Even after ^{90}Sr was fed for four generations of animals there was no marked diminution of liver function, as measured by the bromsulfonphthalein excretion test. (BBB)

28668 PROTEIN SYNTHESIS DURING SPERMATOGENESIS IN DROSOPHILA MELANOGASTER. Brink, N. G. (Univ. of Leiden). Mutat. Res., 5: 192-4(Jan.-Feb. 1968).

The incorporation of tritium-labeled lysine into the germ cells of male Drosophila was studied. Since actinomycin, chloramphenicol, and puromycin have been shown to affect the frequency of x-ray-induced mutations in Drosophila, the possible effects of these compounds on the incorporation of labeled lysine was also studied. The testes of treated flies were excised ¼, ½, 4 and 24

hr after injection of tritium-labeled lysine and autoradiographs of them were measured for grain count per cell at various stages of spermatogenesis. Label was present in both early and elongating spermatids, indicating that protein synthesis was taking place during spermatogenesis. The uptake of labeled lysine was not affected by actinomycin, chloramphenicol, or puromycin. (M.M.B.)

28669 REMOTE SEQUELAE OF RADIATION IN THE BLOOD SYSTEM. Akoev, I. G. Med. Radiol., 13: 21-7(Jan. 1968). (In Russian).

An analysis of pertinent literature findings and also the author's personal data concerning changes in irradiated dogs of the rate of ^{59}Fe inclusion into erythrocytes and cytological composition of the blood and bone marrow led to the conclusion that after radiation injury for prolonged periods of time there may be noted intensified erythropoiesis and latent normal or leukopenic blood picture. This intensification may be the cause of retarded and unstable normalization of other hematopoietic series. In investigations with ^{51}Cr-labeled erythrocytes it was shown that this intensification of hematopoiesis is associated with accelerated diminution of erythrocytes from the vascular channel. (auth)

28670 THE MECHANISM OF RADIATION ACTION IN LEUKEMOGENESIS. THE ROLE OF RADIATION IN LEUKEMIA DEVELOPMENT. Haran-Ghera, Nechama (Weizmann Inst. of Science, Rehovoth, Israel). Brit. J. Cancer, 21: 739-49(Dec. 1967).

The experimental results described indicated that radiation could contribute to x-ray-induced leukemogenesis in C57Bl mice, by causing transient depression of the immune mechanism, in addition to its known effects on thymus and bone marrow injury and the release of the leukemogenic agent. A sensitive testing system of injecting the leukemogenic filtrate into a several-day-old thymus implant under the kidney capsule of thymectomized irradiated mice (550 R whole-body exposure) was used to examine this hypothesis. In this testing system, when irradiation was omitted, there was a marked reduction in the lymphoma incidence, even though the leukemogenic agent was inoculated into the test mice in abundance. Immune reactivation of the irradiated hosts by bone marrow or spleen shielding, or by injection of spleen and lymph node cells shortly after irradiation, caused a significant decrease in the incidence of lymphoma induction. The rate of lymphoma development was related to the x-ray dose of the host. The effective minimal dose for tumor development was 250 to 300 R, while 550 R whole-body irradiation was maximally effective, coinciding with the relation of x-ray dose to induction of immune impairment. Studies of the immune defect caused by irradiation suggested that cellular immunity impairment of the homograft reaction type could be involved in the neoplastic proliferation. Irradiation of the host was equally effective whether applied shortly before or after agent inoculation, but delaying irradiation beyond 30 days after the leukemogenic filtrate inoculation caused a progressive decrease in leukemia incidence. (BBB)

28671 EFFECTS OF RAINWATER RADIOACTIVITY ON ORGANISMS. Mikami, Yoshiki; Muto, Tatsukichi; Agawa, Yoshiyuki; (and others) (Mie Prefectural Univ., Tsu, Japan). Mie Kaibo Gyosekishu, 16: 1-27(Aug. 1965). (In Japanese).

Fertilized fish eggs and various strains of mice were used to study the effects of rainwater radioactivity (fallout from nuclear explosions) on the development and function of various organisms. The results showed that even a slight amount of rainwater radioactivity, i.e., 5 cpm/l for the ICR/JCL strain mouse cause disturbances in embryonic development that resulted in stillbirths or malformations. Also, the maternal brain, endocrine organs, and hematopoietic organs were affected. In some experiments the eggs of the tropical fish, Zebra danio, were used. A 92-mg dry residue obtained from rainwater collected after the Bikini nuclear tests in 1954 (with a radioactivity of 50 cpm/l) was redissolved in tap water to prepare 25, 50, 250, 500, and 2500 cpm/l solutions in which 1-hr-old fertilized eggs were incubated. In another experiment, 6-hr-old fertilized eggs were exposed to 714, 952, 1190, and 1786 cpm/l solutions at 16°C. The survival rate of control fish embryos was 92%. In the solution containing 25 cpm/l it was 91% and in the 50 cpm/l solution 92%, the same as in the controls. However, in 250 cpm/l solution the survival rate decreased to 76%, at 500 cpm/l to 70%, at 714 cpm/l to 6.6%, at 952 cpm/l to 16.6%, at 1110 cpm/l to 10%, and at 1786 and 2500 cpm/l to 0%. Thus the survival rate decreased markedly as the radioactivity increased. The incidence of malformations in the control group was 0%; at 25 cpm/l, 27%; 50 cpm/l, 24%; 250 cpm/l, 43%; and at 714 cpm/l, above 100%. (154 references). (BBB)

28672 HISTOLOGIC CHANGES IN X IRRADIATED TISSUE. Gahlen, W. (Technische Hochschule, Aachen). Aesthet. Med., 15: 193-201(June 20, 1966). (In German).

The author describes several clinical examples of x irradiation injuries of skin and exemplifies many of the histological skin changes caused by x irradiation. These are illustrated by means of skin sections that indicate various irradiation effects. The effects shown are pseudoacanthosis with incondinence of melanin, atrophy of the hair follicle, homogenization of the collagen, subepidermal edema, atrophy of the epidermis, sweat gland degeneration, proliferation of arterial endothelium, vascular sclerosis, obliteration of subcutaneous vessels, initiation of teleangiectasis, teleangiectasis and hyperkeratosis, necrobiosis with teleangiectasis, and incipient carcinoma. The author describes and discusses the events and tissue changes that take place in skin following x irradiation and shows their relations and sequence. The results of the study include a discussion of results obtained by other investigators. (BBB)

28673 INFLUENCE OF IRRADIATION ON THE SUSCEPTIBILITY OF THE GUINEA PIG TO INFECTION WITH CLOSTRIDIUM WELCHII TYPE A. Fredette, V.; Ghys, R.; Plante, Claudette (Univ. of Montreal, Canada). J. Pathol. Bacteriol., 95: 275-80(Jan. 1968).

Guinea pigs that were irradiated at 100- to 290-R doses (^{60}Co γ radiation) were inoculated with various doses of two strains (Lechien and SWG 121) of C. welchii to examine the effect of irradiation on susceptibility to infection and virulence. In the first experiments (strain Lechien) 1 ml of a 1:15 dilution (expected LD_0) of the standardized suspension (expected LD_{100}) was injected into the thigh muscle of 10 guinea pigs that had received 290 R five days previously. Twenty-four hr after injection, five of the irradiated guinea-pigs had generalized gas gangrene, three had edema over the inoculated thigh, and two showed no symptoms. On the other hand, injection of the 1:15 dilution produced no symptoms in the normal guinea pigs, whereas guinea pigs that had received the undiluted suspension had generalized gas gangrene. Eventually 40% of the irradiated guinea pigs died from generalized gas gangrene while none of the normal animals that received the same dose died; in comparison, 60% of the normal guinea-pigs that received the undiluted suspension died. The other experiments (strain SWG 121) showed that choice of a dose of 290 R five days before infection was optimal. Irradiation doses of 100 and 200 R exerted hardly any effect. If injection of C. welchii was delayed for either 11 or 21 to 22 days after a radiation dose of 250 to 290 R, some animals died with radioinduced internal hemorrhage; survivors of the radiation syndrome had a practically normal sensitivity to C. welchii. (BBB)

28674 EFFECT OF IRRADIATION ON DEVELOPING TEETH. Weyman, Joan (Sutherland Dental School, Newcastle-upon-Tyne, Eng.). Oral Surg., Oral Med., Oral Pathol., 25: 623-9(Apr. 1968).

A brief review of the effects of x radiation on developing teeth is given. These deal with patients who have had a considerable dosage. A case history is given of a child who had received a very low-level dose (400 R) of x radiation at 5 months of age and who was followed up for 15 years. (auth)

28675 INFLUENCE OF X WHOLE-BODY IRRADIATION ON THE INCORPORATION OF 2-^{14}C-GLYCINE IN THE PROTEINS OF THE LIVER, SPLEEN, AND THE BLOOD OF RATS. Maass, H.; Jenner, E.; Hoelzel, F. (Univ., Hamburg). Z. Naturforsch., 22: 634-8(June 1967). (In German).

Whole body irradiation with 800 R caused a three fold increase of radiactivity in the liver and spleen proteins of rats. Analysis of the radioactivity of the precursor pool showed an increase of ^{14}C activity to the same degree as found for the proteins. Thus the increase of the incorporation rate of ^{14}C-glycine into the proteins is simulated, and consequently there is no change of the protein synthesis in the liver of an irradiated rat as measured with ^{14}C-glycine. This is probably true for the rat spleen also. (auth)

28676 CYCLIC X RAY RESPONSES IN MAMMALIAN CELLS IN VITRO. Sinclair, Warren K. (Argonne National Lab., Ill.). Radiat. Res., 33: 620-43(1968).

Various radiation responses in mammalian cells depend on the age of the cells at the time of irradiation. Studies were made by irradiating synchronized populations of cells in vitro. Results in different cell lines were not easy to compare, but an attempt was made to point out similarities and differences with regard to cell killing and division delay. Survival data obtained so far showed that, in cells with a short G_1 (the period before DNA synthesis begins), cells were most sensitive in mitosis and in G_2 (the post-DNA synthetic period), less sensitive in G_1, and least sensitive during the latter part of the S period (the time at which DNA synthesis is in progress). In cells with a long G_1, there was usually a resistant phase early in G_1 followed by a sensitive stage near its end. The latter may be as sensitive as mitosis. Exceptions especially in some mouse L cell sublines, were noted. In

Chinese hamster cells, maximum survival after irradiation occurred during S, but it did not coincide with the time of the maximum rate of DNA synthesis or with the time of the maximum number of cells in DNA synthesis. Changes in survival also occurred in cells inhibited from synthesizing DNA. Rather, survival depended on the age of the cell. Survival was not completely correlated with DNA synthesis, since halting DNA synthesis just before or just after irradiation only slightly affected survival at its maximum. Division delay exhibited a pattern of response which was similar in most cell lines. Delay was considerable for cells irradiated during mitosis, was small for cells in G_1, increased to a maximum for cells during S, and declined for cells in G_2. Mouse L cells or human kidney cells may have a longer delay for cells irradiated in G_2 than for those irradiated in S. The results were explained in terms of a two-component model of division delay. One component resulted from the prolongation of the S period due to the reduced rate of DNA synthesis, and the other, a block in G_2, was independent of DNA synthesis. The proportion of the two components probably varied in different cell lines. (A.W.B.)

28677 ECHOENCEPHALOGRAPHIC OBSERVATION OF BRAIN EDEMA INDUCED BY IRRADIATION. Son, Yung H. (Yale Univ., New Haven). Clin. Radiol., 19: 77-82(Jan. 1968).

Serial echoencephalographic examinations were carried out in 5 patients who had received radiotherapy for cerebral metastases. The site of cerebral metastasis was accurately determined by echoencephalography in 4 of the 5. The degree of midline shift was increased by irradiation, being greatest in the immediate and 6-hour post-irradiation periods. It was less marked at 24 hours. A small dose of 50 rads seemed to increase cerebral edema to a significant degree. Corticosteroids helped to control symptoms of increased intracranial pressure and to return the echo to the normal position. (auth)

28678 RADIATION PROTECTION ADJACENT TO SCAR TISSUE. Hulbert, M. (St. Marys' Hospital, London). Brit. J. Radiol., 41: 234(Mar. 1968).

Observations on a patient given a total dose of 4,125 rads γ radiation to the head during a five-week period of treatment following partial craniotomy indicated that the acute effects of radiation were less severe in tissues that had been altered by scarring. Hair follicles in the immediate neighborhood of the scar escaped the full epilation effect. It was concluded that this was a direct clinical illustration of the oxygen effect since the protective effect was attributed to the action of relative hypoxia induced by the diminished blood supply of the scar tissue. (C.H.)

28679 RADIOSENSITIVITY OF THE HUMAN OXYGENATED CERVICAL SPINAL CORD BASED ON ANALYSIS OF 357 CASES RECEIVING 4 MeV X RAYS IN HYPERBARIC OXYGEN. van den Brenk, H. A. S.; Richter, Wendy; Hurley, R. H. (Cancer Inst., Melbourne). Brit. J. Radiol., 41: 205-14(Mar. 1968).

The incidence is recorded of radiation-induced myelitis of the cervical cord in 357 patients receiving 4 MeV fractionated x irradiation in hyperbaric oxygen (HPO) at 4 ATA. Radiation myelitis is a dose-dependent phenomenon showing multihitness of effect. It was analyzed in terms of a cell survival model, assuming a D_0 = 130 rads and extrapolation number m = 2 for this tissue. The risk of patients developing myelitis in HPO in terms of the percentage of affected patients was calculated. An attempt was made to compare these findings with reports in the literature of CNS damage following more conventional irradiation delivered in air, with a view to estimating relative radiosensitization of this tissue by hyperbaric oxygen in radiotherapy. The incidence appears higher in HPO, but data reported for air treatments are insufficient for a more conclusive statement to be made. (auth)

28680 SOME SPECULATIONS ON THE CARCINOGENIC EFFECT OF INHALED ALPHA-ACTIVE MATERIAL. Bevan, John S.; Haque, A. K. M. M. (Borough Polytechnic, London). Phys. Med. Biol., 13: 105-12(Jan. 1968).

Calculations are reported on the possible size of malignant foci in cases of lung cancer attributable to the inhalation of α-active material. It is shown that the number of cells in these foci probably lies between 15 and 20, and that the proportion of cells in the bronchi damaged by low doses of radiation may be as high as 20% to 25% of the cell population at risk. (auth) (UK)

28681 RADIATION ACCIDENTS IN PEACETIME. DOSIMETRIC AND SANITARY PROBLEMS. Hajek, Vlastimil (Slovak National Uprising Military Hospital, Ruzomberok, Czechoslovakia). Voj. Zdravot. Listy, 36: 176-80(Aug. 1967). (In Czech).

A review of radiation accidents that occurred in Czechoslovakia during 1945 to 1964 is presented. Physical and biological dosimetry problems are reviewed. Clinical symptoms of radiation sickness are reviewed and reasons for late consequences and methods of successful therapy of victims of accidents that occurred in atomic industrial plants are evaluated. Treatment of victims of a postulated nuclear attack is discussed. (JPRS) (TSS)

28682 SOME MORPHOLOGICAL CHANGES OBSERVED IN RABBIT HEART SUBSEQUENT TO X-RAY IRRADIATION. Psenicka, P. (Karlova Univ., Hradec Kralove, Czechoslovakia). Cesk. Fysiol., 16: 380(July 1967). (In Czech).

Experiments on rabbits that received a dose of 1,000 R are described. Heart muscles are relatively resistant to x irradiation. Parts of the heart become swollen as a result of the irradiation, and their structure is damaged. The plasma contains large numbers of vacuoles, some fibers disintegrate, and nuclei become pycnotic. In blood capillaries and larger veins frequent stasis was found. (JPRS)

28683 PROBLEM OF STOMACH CLEARANCE IN IRRADIATED RATS. Grossmann, V.; Visnovskii, P. (Karlova Univ., Hradec Kralove, Czechoslovakia). Cesk. Fysiol., 16: 360-1(July 1967). (In Czech).

Experiments on eight male rats irradiated with a dose of 800 R are described. Irradiation increases the acidity in the stomach. Administration of atropine in amounts of 150 to 250 micrograms per kg of weight decreases the acidity; low amounts of atropine increase the weight of the stomach content after irradiation, amounts exceeding 300 micrograms per kg reduce this weight. (JPRS)

28684 EFFECT OF IONIZING RADIATION ON INHIBITION IN THE SPINAL CORD. Barnes, Charles D. (Indiana Univ., Bloomington). Radiat. Res., 32: 347-54(1967).

The effect of radiation on spinal cord inhibitions was determined in experiments performed on 54 cats, either decerebrate at the intercollicular level or anesthetized with pentobarbital sodium. Irradiation was done at dose rates of 10, 33, 50, and 100 R/min, with 250-kVp x ray at 25 mA, with filtration of 0.5 mm Cu and 1 mm Al for a total accumulated dose of up to 2000 R. By utilizing the monosynaptic reflex of L_7 or S_1 and conditioning pulses at dorsal L_6 or a ventral branch of L_7 as well as dorsolateral cord surface recordings, it was possible to assess direct, recurrent, and presynaptic inhibition before, during, and after irradiation. The monosynaptic reflex alone was found to increase on 21 animals and to decrease on 26; seven gave fluctuating amplitude changes or none at all. The only inhibition to show a consistent change with irradiation was presynaptic inhibition, that increased in strength at any given time and became longer lasting. (auth)

28685 EFFECT OF ELIMINATION OF THE LABYRINTH FUNCTION IN INCREASING RADIATION SENSITIVITY FROM THE STANDPOINT OF RADIATION SAFETY IN SPACE FLIGHTS. Arlashchenko, N. I. Radiobiologiya, 7: 350-6(1967). (In Russian).

Irradiation of rabbits that had survived for 25 days after bilateral labyrinthectomy or of control rabbits with intact labyrinths with γ-rays at a dose of 650 R resulted in the death of 60% of the animals, whereas irradiation with the same dose during the period of the most acute vestibular disturbances of rabbits subjected to labyrinthectomy on one or both sides resulted in death of all animals. Because the effect of weightlessness is the same as that of labyrinthectomy in producing vestibular disturbances, the results indicated that weightlessness during space flights should increase sensitivity to radiation. (JPRS)

28686 CUES: THEIR RELATIVE EFFECTIVENESS AS A FUNCTION OF THE REINFORCER. Garcia, J.; McGowan, B. K.; Ervin, F. R.; Koelling, R. A. (Harvard Medical School, Boston, Massachusetts General Hospital, Boston). Science, 160: 794-5 (May 17, 1968).

Two cues, either size or flavor of food pellet, were conditionally paired with either malaise induced by x-ray or pain induced by shock in four groups of rats. The combination of flavor and illness produced as conditioned decrement in consumption, but that of size and illness did not. Conversely, the combination of size and pain produced an inhibition of eating, but flavor and pain did not. Apparently, effective associative learning depends on central neural convergence of the paired afferent input. (auth)

28687 PHOTOALLERGY CAUSED BY TRIACETYLDIPHENOLISATIN (TDI). I. CASUISTICS. Jung, E. G. (Univ., Heidelberg). Arch. Klin. Exp. Dermatol., 229: 170-3(Aug. 1, 1967). (In German).

In skin tests made on two female patients shortwave uv light of less than 320 nm induced skin reactions in areas tested with triacetyldiphenolisatin (TDI). This substance was used as a component of some laxatives because of its low toxicity. The photoallergy induced required more energetic uv irradiation than other

photoallergins such as sulfonamides, phenothiazine, and halogenated salicylanilides. The patients studied exhibited photoallergies only after exposure to strong sunlight; this indicated a requirement for large amounts of shortwave uv quanta. In 25 other patients used as controls no photoallergies were seen when TDI was used with exposure to shortwave uv. (BBB)

28688 PROBLEM OF POSTIRRADIATION RETENTION OF THE STOMACH CONTENT IN RATS AS A FUNCTION OF THE IRRADIATION OF A DEFINITE PART OF THE BODY. Visnovskii, P.; Grossmann, V. (Karlova Univ., Hradec Kralove, Czechoslovakia). Cesk. Fysiol., 16: 378-9(July 1967). (In Czech.).

Experiments conducted on male rats irradiated with a dose of 600 R are described. The highest retention was found after a whole-body irradiation; when only the center of the body was irradiated, the content was slightly reduced. When only the head was irradiated, the content retained was the smallest, but beginning with the third day after irradiation there was a return to normal stomach functioning. (JPRS)

28689 RISK OF THYROID NEOPLASMS AFTER IRRADIATION IN CHILDHOOD. Hempelmann, Louis H. (Univ. of Rochester, N. Y.). Science, 160: 159-63(Apr. 12, 1968).

The incidence of thyroid carcinoma and of clinically palpable thyroid nodules is compared in three groups of individuals many years after exposure to ionizing radiation in childhood or infancy. The estimated mean cumulative doses to the thyroid gland ranged from 20 rad in the Ann Arbor series irradiated with x rays as infants for thymic enlargement upward to 1225 rad of mixed radiation (including that from ingested radioiodine) in the Marshallese children. Intermediate between these extremes is the high-risk subgroup in the Rochester series of persons irradiated for thymic enlargement; they received an estimated mean thyroid dose of 335 rad. A plot of the incidence of thyroid nodularity against the total cumulative thyroid dose gives what could be a linear dose response with no threshold or, at least, a threshold below 20 rad. The risk of developing carcinoma in the three studies ranges from 0 to 5.5 cases and that for nodularity 38 to 52 cases per 10^6 persons exposed per rad (thyroid dose) per year. There is evidence from animal experimentation that the biologically effective dose in the case of the Marshallese would have been considerably lower than the cumulative physical dose; hence, the dose response might actually be curvilinear at least in the higher dose range. In view of the uncertainties regarding dose and the assumptions made in my study, the risk values may not be exact; however, these values reflect the trends regarding risks estimated from the best available data in man. Furthermore, the estimated risk values apply only if radiation exposure occurred in childhood. (auth)

28690 COMPLICATIONS AFTER RADICAL HEAD AND NECK SURGERY PERFORMED THROUGH PREVIOUSLY IRRADIATED TISSUES. Marchetta, Frank C.; Sako, Kumao; Maxwell, Walter (Roswell Park Memorial Inst., Buffalo). Amer. J. Surg., 114: 835-8(Dec. 1967).

It was found that radical surgical procedures on the neck performed after cancericidal doses of x radiation were administered resulted in a marked increase in postoperative morbidity and wound complications. The report included 83 patients who received x radiation during treatment for cancer of the head and neck. Irradiation, as a rule, was delivered by a 200- or 400-KV x-ray machine that delivered a skin dose of 6000 R over a period of 30 days. The reports covered the area of primary involvement and the upper cervical area of the neck. In some instances, patients received a second course of therapy several weeks or months after the first. In the patients receiving irradiation, primary healing after surgery occurred in 47. In 36 patients (43%) one or more wound complications developed. Six (7%) of the irradiated patients had perforated carotid arteries and two of these died. This complication did not develop in any of the control patients who were irradiated. Radiation effects, divided clinically into three stages, are discussed. (BBB) (TSS)

28691 EFFECTS OF IONIZING RADIATION ON THE EUROPEAN CHAFER, THE PLUM CURCULIO, AND THE LARGE MILKWEED BUG. Lippold, P. C.; Gambrell, F. L.; Massey, L. M, Jr. (New York State Agricultural Experiment Station, Geneva). Ann. Entomol. Soc. Amer., 61: 151-8(Jan. 1968).

A study was made of the effects of ^{60}Co γ radiation on the longevity of three insect species, the European chafer, Amphimallon majalis; the plum curculio, Conotrachelus nenuphar; and the large milkweed bug, Oncopeltus fasciatus. The two first-mentioned species were of economic importance in New York State. Significant irradiation mortality occurred after two days' exposure at doses ranging from 25 to 125 KR. With the plum curculio, irradiation of adults at a dose of 500 KR resulted in early death. Curculios exposed to 100 KR did not survive more than four days. A dose of 2 KR to adult curculios resulted in an 87% decrease in F_1 adult progeny, with a 31% decrease in F_2 progeny. An LD_{50} value of 6.8 days was obtained for female curculios at 50 KR; at the 10-KR dose the LD_{50} value was >10 days. The LD_{50} values for male curculios were 5.8 and 10.3 days, respectively, at 50- and 10-KR doses. Adult milkweed bugs were more tolerant to irradiation than plum curculio. An LD_{50} value of 12.5 days was obtained for female large milkweed bugs at a dose of 50 KR. Hatch of eggs from 1-KR-treated females was reduced two days after treatments. Normal hatch was recorded at three days and total number of eggs did not differ from the controls. With one- and four-day-old eggs at a dose of 5 KR, 55% hatch of four-day eggs was obtained. None of the one-day eggs hatched at this dose. Eggs of 0-, one-, and four-day age were submitted to excessively high doses of 100 and 500 KR. Only 1% hatch was obtained with four-day-old eggs at the 100-KR level. (BBB)

28692 EXTRINSIC LARYNGEAL CARCINOMA: A CLINICAL EVALUATION OF 124 CASES. Lawrence, Knowles B.; Rybka, F. James; Murray, Joseph E.; Constable, John D. (Veterans Administration Hospital, Boston). Amer. J. Surg., 114: 503-6(Oct. 1967).

Complications of preoperative radiotherapy in 124 patients with cancer of the larynx are reported with special attention to the effects of different types of radiation used and treatment and prevention of radioinduced injuries. Radiation therapy was given to 18% of the patients before combined laryngectomy and neck dissection to reduce recurrences by sterilizing the field about the tumor and to diminish the viability of cancer cells which might implant during surgery. The hazards of preoperative radiation therapy were evident. After the use of orthovoltage x ray (from 1952 through 1958) in doses ranging from 3500 to 6000 R, tissue viability and healing were clearly impaired and contributed considerably to the 21% operative and in-hospital mortality of combined radical laryngectomy and neck dissection. Pharyngeal suture line dehiscence and fistulization, progressive wound infection and necrosis, and carotid rupture were prominent causes of such deaths. Delay in surgery of more than a few weeks after completion of radiation therapy increased the degree of tissue change and of these complications. With the adoption of supervoltage therapy followed by surgery within three to six weeks, the viability of tissues and the resistance to infection were much improved in individual cases. A drop in operative and in-hospital mortality rate to 9.6% for the years 1958 through 1963 paralleled this use of supervoltage therapy preoperatively. Various technical maneuvers, including the fashioning of skin flaps to ensure viable skin over the carotid artery, effective wound suction to maintain skin flap adherence, appropriate antibiotic therapy and blood replacement, and the protection of the exposed carotid artery by pedicled levator scapulae muscle, were helpful in obtaining local healing after radiotherapy. (BBB)

28693 FURTHER OBSERVATIONS ON REACTION TIME AND FLICKER FUSION IN "NORMAL" HUMANS UNDER DAILY IRRADIATION. Feder, B. H. (Veterans Hospital, Long Beach, Calif.); Boswell, R. S.; Schaeflein, J. W.; Sondhaus, C. A.; Stuhlbarg, J. Contract DASA-01-67-C-0136. Radiology, 90: 355-8 (Feb. 1968).

Studies on the physiological radiosensitivity of the central nervous system in man were conducted on two patients with nasopharyngeal malignant tumors in which a portion of the brain, brain stem, and upper spinal cord received irradiation incident to therapy. Two opposing fields were exposed to γ radiation at an estimated dose to the middle of the nasopharynx of about 170 rads per daily treatment session. The daily irradiation was given in two of four randomized periods and irradiation was shammed during the other two periods. The patients' ability to detect irradiation and the effects of irradiation upon flicker-fusion frequency (FFF) and reaction time (RT) were measured. The total data for analysis included approximately 600 FFF and 3,000 RT measurements. Results showed that humans may detect irradiation because of the phosphene effect on the retina; moderate doses of irradiation may cause a transient increase in central nervous system excitability; transient increases in FFF occur when part of the brain is irradiated; and transient decreases in reaction time may occur when part of the brain is irradiated. (C.H.)

28694 HEMOPOIETIC SPLEEN COLONIES IN THE RAT. Comas, Frank V.; Byrd, Billy L. (Oak Ridge Inst. of Nuclear Studies, Tenn.). Radiat. Res., 32: 355-65(1967).

Hemopoietic spleen colonies were obtained in Fischer-334 rats by injecting isologous bone marrow cells into heavily irradiated recipients. Whole-body irradiation doses as high as 1400 rads did not inhibit the development of endogenous colonies. These colonies, however, were very small, seldom exceeding 1 mm in diameter. In contrast, exogenous spleen colonies, observed 12 days after

bone marrow infusion, had a mean diameter of 1.3 mm and could be easily counted when colonies measuring less than 1 mm in diameter were not scored. The number of colony-forming units in rat bone marrow was between four and five per 10^5 cells. Most of the endogenous and exogenous spleen colonies showed erythroid differentiation, but myeloid elements and a few megakaryocytes could also be observed. (auth)

28695 INDUSTRIAL HYGIENE PROBLEMS OF WORKING AROUND ULTRASHORT-WAVE TRANSMITTERS USED IN TELEVISION AND BROADCASTING. Goncharova, N. N.; Karamyshev, V. B.; Maksimenko, N. V. Gig. TR. Prof. Zabol., No. 7, 10-13 (1966). (In Russian).

A hygienic assessment of personnel working conditions around ultrashort-wave generators was conducted. The clinical effect of a wide range of EMF's was also studied. The tests were run in TV transmission centers where 2 to 5 kw, 67 to 230 Mc (VHF) transmitters were used. The basic causes of EMF were inadequate shielding of HF components such as oscillating systems, air capacitors, generator tubes, power bridges and antenna components. Measurements of EMF power intensity were conducted using a LIOT dosimeter and the results showed that the average strength of EMF's (5 v/m) exceeded the permissible values recommended by Z. V. Gordon and P. P. Fukalova. Around control panels, intensity reached 8 to 15 v/m, around TV transmitters, 23 to 68 v/m, and around bridges, 8 to 30 v/m. It was also noted that 30% of the working shift was spent around transmitters where the field intensity fluctuated between 23 and 150 v/m. About 50% of the time was spent behind the control panel (8 to 9 v/m), and 20% in the absence of any EMF. Physiological examinations were conducted on 51 subjects, 27 of whom had working periods of three to eight years and 24 of whom served as controls. It was observed that the working group experienced shifts in nervous and cardiovascular system function. At the end of the working shift there was an increase (by 13 mm Hg) in systolic pressure and prolongation of speech and visual motor reactions. Central nervous system reactivity was not equivalent in the two groups; a study of speech and visual motor reactions showed that reaction speed was decreased by 17 to 34 σ in workers, while it was increased by 11 to 17 σ in control subjects. To detect shifts in the state of the nervous system, an olfactometric approach was used. Rosemary (sympathicotropic agent), thymole (parasympathicotropic agent), and camphor (no essential autonomic effect) were used. An increase in worker olfactory threshold was found, indicating central nervous system inhibition both in the autonomic and sympathetic spheres. Analogous results were obtained in a study of the peripheral nervous system; finger chronaxie was somewhat prolonged (0.03 to 0.05 m/sec) in workers, while shortened in control subjects. This slight increase in chronaxie apparently indicated a decrease in the neural excitation generation rate. It was concluded that prophylactic measures were called for to decrease EMF intensity in TV and radio stations. (ATD)

28696 SOLUBLE PROTEINS OF THE BRAIN AND INTESTINAL WALL OF IRRADIATED ANIMALS. Makhlina, L. M.; Abuzina, G. N. Radiobiologiya, 7: 472-4(1967). (In Russian).

Under normal conditions, paper electropheresis with tris-buffer of soluble proteins of the rat brain resulted in separation into 8 to 9 fractions, and that of soluble proteins of the wall of the small intestine, in a veronal buffer, into 7 to 8 fractions. Within 72 hrs after irradiation of rats at a 1000 R dose of x irradiation, the fractional composition of soluble proteins of the brain remained practically unchanged while the proteins of the intestinal walls were altered significantly both qualitatively and quantitatively. The results indicated that differences existed in the radiosensitivity of the two organs. (JPRS)

28697 STUDIES ON DOSE FRACTIONATION AS MEASURED BY ENDOGENOUS SPLEEN COLONIES IN THE MOUSE. Chaffey, John T.; Hellman, Samuel (Yale Univ., New Haven, Conn.). Radiology, 90: 363-5(Feb. 1968).

Differences in clinical dose fractionation were compared, using endogenous mouse spleen colonies as the assay technic. A single-dose survival curve was obtained. Daily doses of 200 R in three to seven fractions resulted in no decrease in colony numbers. Two hundred fifty R daily gave fewer colonies but also showed a tendency to level off. Differences obtained by varying one- or two-day rest periods within a treatment course are presented. (auth)

28698 THERMAL MODEL FOR RETINAL DAMAGE INDUCED BY PULSED LASERS. Hayes, Jude R.; Wolbarsht, Myron L. (Naval Medical Research Inst., Bethesda, Md.). Contract MIPR 535-67. Aerosp. Med., 39: 474-80(May 1968).

The model of the retina employing the thermal absorption of a slab of the pigment epithelium layer (assumed to be homogeneous) was examined in detail for both long exposure times (for which it was designed) and short exposure times to pulsed lasers. This model was sufficient to explain the damage from long exposures but not short exposures. The physical characteristics of the pigment epithelium were examined, particularly with respect to the thermal stability and optical properties of the melanin granules. A new model is proposed which is based on absorption of the incident energy by the one micron diameter pigment granules and thermal conduction from them to nearby essential retinal structures such as the pigment cell membrane and the receptor cell myeloid body and outer segment. The new model explains both long and short pulse effects. Such nonlinear effects as ionization from intense electric field gradients, harmonic generation, Brillouin scattering, shock waves, and reradiation by black body emission are shown to make negligible contribution to the initial tissue damage where the lesion is minimal. Shorter event times (10^{-12} seconds) which are possible from mode locked laser operation may require other mechanisms than postulated by this theory. (auth)

28699 INCIDENCE OF ENDOGENOUS BACTERIAL INFECTION IN MURINE RADIATION CHIMERAS WITH SECONDARY DISEASE. Watson, James Richard. Urbana, Ill., Univ. of Illinois, 1967. 117p.

Thesis.

Lethally irradiated B6D2F$_1$ mice injected with C$_{57}$B1/6 bone marrow cells showed good 28 day survival. Thereafter, many of the chimeras developed secondary disease. The impaired immune mechanism and the severe lymphoid hypoplasia associated with secondary disease prompted an investigation of the possibility that bacterial infection might play a role in this syndrome. One hundred and four conventional chimeras and 421 Specific Pathogen Free (SPF) animals showing well-developed secondary disease were sacrificed between the 29th and 52nd day post-irradiation. Their organ homogenates and a drop of heart's blood from each mouse were cultured on bacteriological media both aerobically and anaerobically. Allogeneic chimeras which did not develop secondary disease but developed radiation grayness served as control animals. The incidence of positive cultures in conventional radiation chimeras with secondary disease was as follows: liver, 52%; spleen, 38%; and heart's blood, 21%. By the 5th experiment, Salmonella infection was so widespread that all of the chimeras had died before the onset of secondary disease. Thereafter, SPF mice were used. In SPF chimeras with secondary disease, 57% had positive liver cultures, 41% had positive spleen cultures, and 25% had bacteremia as indicated by positive heart's blood cultures. None of the controls had positive cultures. The body weight of these chimeras averaged 23.5 grams. In marked contrast, the body weight of the average animal with secondary disease was reduced to 14.4 grams. The findings of this research show that the incidence of endogenous bacterial infection was consistent regardless of the onset of the wasting syndrome and that bacterial involvement plays a definite role in secondary disease. (Disser. Abstr.) (TSS)

Radiation Effects on Plants

Refer also to abstracts 28271, 28285, 28286, 28288, 28360, 28390, 28400, 28402, 28406, 28412–28414, 28416, 28420, 28421, 28423, 28424, 28444, and 28542.

28700 (ANL–7278, pp 283-96) PLANT RADIOBIOLOGY. (Argonne National Lab., Ill.).

ANGIOSPERMIDAE — Xanthium sp., radiation effects on flowering of, effects of gibberellic acid on x; Oenothera biennis, inhibition of flower bud opening in, by green light; Pharbitis nil, inhibition of flower bud opening in, action spectrum and spectral reversibility of light-induced; Nicotiana tabacum, germination of seeds of, action spectrum for light-induced; Zea mays, transport of auxin by seedlings of, effects of light on; Zea mays, transport of carbon-14-labeled auxin by, effects of bilateral illumination and temperature on; Nicotiana tabacum, radioinduced inactivation of buds of, effects of, on tumor formation

HORMONES, PLANT — auxins, transport of, effects of radiant energies on inhibition of (H.L.W.)

28701 (ANL–7278, pp 297-303) GROWTH AND DEVELOPMENT OF PLANTS IN COMPENSATED GRAVITATIONAL, MAGNETIC, AND ELECTRICAL FIELDS. (Argonne National Lab., Ill.).

ANGIOSPERMIDAE — Vicia faba, radiosensitivity of chromosomes of, effects of gravitational force on x; Avena sativa, determination of phototropic responses of seedlings of, effects of gravitational compensation on; Avena sativa, determination of acceleration magnitudes for geoperception in seedlings of; development, growth, and metabolism of, effects of simulated low-gravity environments on; Avena

sativa, respiratory metabolism in seedlings of, effects of simulated low-gravity environment on; Zea mays, radiation effects on transport of carbon-14-labeled auxin in, effects of gravity on x

INSTRUMENTS—design of magnetic-relay detector for determination of rotational rate; design of recycling automatic device for sampling gas from constant-flow respirometer (H.L.W.)

28702 EFFECTS OF INTERNAL ^{137}Cs RADIATION ON SEEDS OF LIRIODENDRON TULIPIFERA. Witherspoon, J. P. (Oak Ridge National Lab., Tenn.). Radiat. Bot., 8: 45-8(Feb. 1968).

Mature Liriodendron tulipifera (tulip poplar) seeds were collected from ^{137}Cs-tagged and control trees. After stratification, all seeds were planted in flats under greenhouse conditions. Germination of controls was almost twice that of tagged seeds. Analysis of seed production showed that control trees produced 2.3 times more filled ovules than tagged trees, thus accounting for germination differences. Lower seed production might be related to internal radiation from ^{137}Cs during floral development and seed formation. (auth) (UK)

28703 EFFECTS OF GAMMA IRRADIATION ON GROWTH AND YIELD OF AGRICULTURAL CROPS. I. SPRING SOWN WHEAT. Davies, C. R. (Agricultural Research Council Radiobiological Lab., Wantage, Eng.). Radiat. Bot., 8: 17-30(Feb. 1968).

The effects of acute doses of γ-irradiation ranging from 250 to 2000 rad delivered to wheat at various stages of growth were investigated. Before tiller initiation was complete, doses of 2000 rad caused premature death, while 750–1250 rad led to the number of tillers and ears being increased by factors of up to three. Some enhancement of tillering was also caused by 500 rad delivered at the 2-leaf stage. These effects were shown to depend on the doses received by the apical meristems; increased tillering was always associated with some retardation in the development of the main axis. In contrast when plants were irradiated after tillering was complete neither the number of tillers nor the number of ears was affected by doses up to 2000 rad. The weight of seed per plant was unaffected by exposure to 500 rad. The effects of 1000 rad were variable, but on the average yield was reduced to about 60 per cent of that in the control; no consistent relationship was found between the effects of this dose and the age when plants were irradiated. The effects of 2000 rad, however, varied greatly during the growing season; exposure, before tillering was complete, inhibited all ear development; at the time of ear emergence yield was reduced to less than a quarter of that of the controls, whereas when irradiation was deferred to the time of anthesis or later, yield was much less affected. All treatments which reduced the yield of seed per plant also caused the weight per seed to be smaller. (auth) (UK)

28704 EFFECT OF VARIOUS DOSES OF γ-RAYS ON THE GROWTH AND DEVELOPMENT OF NICOTIANA TABACUM L. Tavdumadze, K. R.; Todua, V. A. Radiobiologia, 7: 475-6(1967). (In Russian).

In experiments carried out on three varieties of tobacco (Sukhumi 959 F-1, Dubecque 44, and Trabezond 1867), irradiation of seeds with γ rays at doses of 2.5 to 10 kR had stimulating effect on the growth and development of the plants in the field. Doses >20 kR, as a rule, inhibited the sprouting, growth, and development of tobacco plants. For air-dried seeds, the LD_{50} was 39 kR. Doses of γ or x rays $\geq$2 kR were lethal for sprouts of the Sukhumi variety that had not been planted and suppressed growth of the stem top of sprouts that had taken root in pots. Gamma rays at doses of 1.5 to 2.5 kR had a stimulating effect on pollen; the ratio of fertilized pods was increased. The LD_{50} for pollen was 7 kR, while doses >10 kR were lethal. (JPRS)

28705 A POTOMETRIC DETERMINATION OF THE EFFECTS OF X-IRRADIATION ON WATER, K AND Ca FLUX IN ISOLATED ROOTS. Lott, J. R.; Wall, M. J. Jr. (North Texas State Univ., Denton). Radiat. Bot., 8: 37-44(Feb. 1968).

A micropotometric technique was used to determine the effects of X-irradiation on the rates of water, calcium, and potassium efflux from excised onion roots (Allium cepa). Calcium and K flux were determined with the aid of an atomic-absorption spectrophotometer. Water efflux was decreased significantly immediately following air exposures of 75 and 100 kR; whereas 50 kR brought about an enhancement of water efflux. Concomitantly, 50 kR appeared to have produced an increase in K and Ca influx and efflux in excised roots. Interestingly, 75 and 100 kR brought about an increase in K efflux from the basal portion as well as an increased K loss into the bathing solution. On the other hand, the higher exposures brought about an increase in Ca efflux from the cut basal end only, and there was no leakage of Ca into the bathing solution. The data indicate separate action of irradiation on water and cation flux in root systems. (auth)(UK)

28706 SOME EFFECTS OF ACUTE GAMMA RADIATION IN GIANT SEQUOIA SEEDLINGS. Taylor, F. G. Jr. (Oak Ridge National Lab., Tenn.). Radiat. Bot., 8: 67-70(Feb. 1968).

Actively growing Giant Sequoia seedlings [Sequoia gigantea (Lindl.)Decne.] received acute γ-radiation from a ^{60}Co source at various dose rates ranging from 42 to 1119 rad/24 hr. While maximum radiation levels (697 and 1119 rad) proved to be sublethal, growth of primary stems was inhibited 28 percent by 134 days postirradiation. Microscopic examination of foliar tissues receiving from 346 to 1119 rad revealed abnormal development of the bascular strand as the result of a reduction of elements per xylem row, extensive development of transfusion tissues, and increased cell wall thickness of some tracheids. Double or twin resin ducts were also observed in leaves receiving 697 rad. (auth) (UK)

28707 EPR EMPLOYED IN RESEARCH OF RADIATION INJURY NATURE OF PLANTS. Grodzinskii, D. M.; Bidzilya, N. I. Tr. Mosk. Obshchest. Isptyt. Prir., Otd. Biol., 16: 121-5(1966). (In Russian).

From Symposium on Free Radicals Processes in Biological Systems, Moscow. See CONF-640635.

The protective effects of iron ions on plants injured by radiation were studied. Seeds were treated with molar solutions of iron hydrochloride before and after γ irradiation; post-irradiation treatment resulted in protection. The protective effects of iron ions on seedlings were studied by placing plants in a solution of iron hydrochloride during γ irradiation. EPR spectra of iron treated seeds showed that iron reduced the yield of paramagnetic centers. EPR spectra of irradiated seeds treated with varying amounts of moisture showed that increases in moisture content increased the rate of free radical recombination. (H.L.W.)

28708 RADIATION-SENSITIVE MUTANT OF ASPERGILLUS NIDULANS. Lanier, W. B.; Tuveson, R. W.; Lennox, J. E. (Univ. of Chicago). Mutat. Res., 5: 23-31(Jan.-Feb. 1968).

A mutant of Aspergillus nidulans was isolated that showed greater sensitivity to uv irradiation and nitrous acid treatment than the strain from which it was derived. The mutation conferring mutagen sensitivity is inherited as a single recessive nuclear gene. Matings that were heterozygous for the mutation exhibited normal recombination between linked markers. Matings homozygous for the sensitivity mutation yielded sterile, dwarf cleistothecia. Heterocaryons in which both of the components carried the sensitivity mutation failed to form somatic diploids. (auth)

28709 THE EFFECT OF γ IRRADIATION OF SEED ON THE NUCLEIC EXCHANGE IN BARLEY ONTOGENY. Chopyak, A. M.; Budnitskaya, E. V.; Stoletov, V. N. (Inst. of Biochemistry, Moscow. Moscow State Univ.). Dokl. Akad. Nauk SSSR, 178: 478-81(Jan. 11, 1968). (In Russian).

The influence of γ irradiation on the metabolism of nucleic acids and proteins in barley (Hordeum) seeds during ontogenesis was investigated using air-dried seeds exposed to 700 rads/min (with doses of 5, 10, and 0 krads). Tabulated data showed that irradiation with 5 krads reduced the content of DNA in the seed bud 24 to 72 hr after germination and in the tubular phase. Irradiation with 10 krads reduced the DNA during 24 hr. after germination, however, as in the case of 5 krad the amount of DNA increased during flowering and earing period. Irradiation with 40 krads destroyed the plant three days after germination. The data obtained indicated that the biosynthesis of nucleic acids and protein are functionally related in the germinating seed and in the mature plant and exhibit a direct correlation. With favorable conditions for germinating seed during the first 24 hr of growth, the content of DNA and RNA in the embryo is increased, as well as the content of protein. Within the 72 hr the absolute content of DNA and RNA and protein continue to increase while the relative (% dry weight) content of nucleic acids is reduced. (R.V.J.)

28710 EFFECTS OF GAMMA IRRADIATION ON GROWTH IN SLASH PINE SEEDLINGS WHEN DIFFERENT PLANT PARTS ARE EXPOSED. Monk, Carl D. (Univ. of Georgia, Athens). Bull. Ga. Acad. Sci., 25: 197-201(Sept. 1967).

Three-week-old slash pine seedlings were irradiated at five exposures with three treatments each: 1) whole plants exposed, 2) roots exposed, and 3) shoots exposed. Seedlings that received both root and shoot exposure tended to be shorter and lighter than those only partially irradiated. Differences in dry weight production were greatest at the higher exposures and in general those parts receiving radiation were affected the most. The root-shoot ratios of shoot-exposed seedlings increased at higher exposures

while a decrease resulted in the ratios in those whose roots were exposed in any form. It was suggested that plants irradiated in nature with roots protected by soil may exhibit greater radiation resistance than if they were irradiated in small pots or removed from the soil. (auth)

28711 STUDIES ON VARIETAL DIFFERENCES IN RADIOSENSITIVITY IN RICE. I. DOSE-RESPONSE CURVE FOR ROOT GROWTH AND VARIETAL DIFFERENCE IN RADIOSENSITIVITY. Ukai, Yasuo (Tokyo Univ.). Ikushugaku Zasshi, 17: 33-6(1967).

When dormant seeds of rice varieties were exposed to various doses of γ rays, marked varietal differences in radiation effect on root growth were observed. It was shown that dose-response curves could be approximated by one general function irrespective of sensitivity. (auth)

28712 THE ROLE OF DOSE RATE, IRRADIATION TECHNIQUE, AND LET IN DETERMINING RADIOSENSITIVITIES AT LOW OXYGEN CONCENTRATIONS. Alper, Tikvah (Hammersmith Hospital, London); Moore, J. L.; Smith, Peter. Radiat. Res., 32: 780-91(1967).

As oxygen concentration increases from zero, the rate of increase in radiosensitivity may be measured by K in the expression r = (m[O] + K)/([O] + K), r being the sensitivity relative to that in complete anoxia, [O] the oxygen concentration, and m and K constants. The value of K depends on the dose rate and the irradiation technique. For Shigella flexneri in suspension, K was greater at high than at low dose rates: and, at high dose rates, it was greater for organisms in aqueous suspension than for those exposed directly to the ambient gas. Changes in the value of K are much more dependent on those variables than on the LET of the radiation. Values of K were compared for 250-kVp x rays and fast neutrons. The value of K was higher with the radiation of higher LET, supporting the hypothesis that reduction in oxygen enhancement ratio with increasing LET may be ascribed to the formation of oxygen in the irradiated material in the tracks of heavily ionizing particles. (auth)

28713 BIOLOGICAL RESISTANCE OF WOOD MODIFIED BY THE METHOD OF RADIATIVE CHEMISTRY. Vaninskaya, Yu. M.; Pinskaya, P. A. Dokl. Akad. Nauk BSSR, 11: 1024-6(Nov. 1967). (In Russian).

The biostability of wood modified by radiochemical methods was studied. Pine (bark and heart wood) and birch wood were used in the study. The modification was accomplished by impregnation with vinyl monomers with subsequent radiation polymerization in a ^{60}Co γ radiation field at a dose outputs of 75 r/sec. The investigation showed that the bark of pine wood, modified with polymethylmetacrylate, showed more stability than controls, seven times more than the untreated bark and two times more than the heart wood. Birch wood, modified by polyvinylacetate, had its stability increased 1.5 times in comparison with controls and more than two times for polystyrol modification. It was found that γ radiation without preliminary impregnation by the monomer did not protect the wood against decay. The combined use of monomer with small quantities of the antiseptic can be used for increase of the biological stability of wood. A method for the significant improvement of the biostability of wood, that guarantees an increased preservation effect, was proposed. (tr-auth)

28714 RADIOSENSITIVITY OF DECIDUOUS TREE SEED TO DIFFERENT RATIOS OF FAST NEUTRON AND GAMMA RADIATIONS. Heaslip, M. B. (Morehead State Univ., Ky.). Radiat. Bot., 7: 415-28(Oct. 1967).

In 1963 to 64 seed samples of dormant Liquidambar styraciflua L., physiologically active Quercus alba L. and Fraxinus americana L., dormant and physiologically active Fuglans nigra L. and Platanus occidentalis L. were each exposed to four levels of fast neutrons and four levels of γ-radiation—16 combinations. Germination and survival, used as a measure of sensitivity, decreased significantly as the level of fast neutron or γ-radiation increased. Significant fast neutron-γ interactions indicate that the effects of these two types of radiation are not additive. Soaked and non-soaked seed samples of the same five species were exposed to 16 new combinations of fast neutrons and γ-radiation in 1964 to 65. The gamma effect on germination and survival of each species was modified by the level of fast neutrons and the seed water content at time of irradiation. The effect of increased water content on fast neutron sensitivity varied between germination and survival of a given species and from species to species. Increasing seed water content preceding fast neutron–γ-irradiation increased the sensitivity of physiologically active Quercus alba L., but decreased the sensitivity of dormant Fraxinus americana L. and Platanus occidentalis L., and the effects were variable from level to level in Fuglans nigra L. Factors affecting the sensitivity of these seed samples to fast neutron and γ-irradiations are discussed. (auth) (UK)

Radiation Effects on Microorganisms

Refer also to abstracts 28288, 28289, 28353, 28354, 28376, 28397, 28404, 28409, 28428, 28537, 28628, and 28725.

28715 LOW OXYGEN ENHANCEMENT RATIOS FOR RADIOSENSITIVE BACTERIAL STRAINS AND THE PROBABLE INTERACTION OF TWO TYPES OF PRIMARY LESION. Alper, T. (Medical Research Council, London). Nature (London), 217: 862-3(Mar. 2, 1968).

When exposed to ionizing radiation bacterial strains which are deficient in ability to by-pass or repair nucleic acid damage show lower oxygen enhancement ratios than their more radioresistant parents. This was predicted from a model in which the principal responsibility for the oxygen effect is attributed to a primary lesion of "type O," whereas a different primary lesion ("type N") is more easily repaired or by-passed by some strains than by others. With certain strains, notably E. coli B, the lethal effects of "type N" lesions are readily modified by post-irradiation culture conditions, and the greater the extent of repair of "type N" damage the higher the oxygen enhancement ratio. The present communication describes some further studies with radiosensitive mutants of E. coli B. It was found that the oxygen enhancement ratio was negatively correlated with sensitivity to U/V light. Results are tabulated and discussed. Evidence of correlation between the sensitivity of a family of strains to U/V light and to X-rays under anoxic conditions, and the negative correlation between OER and radiosensitivity, add to the plausibility of inferring that "type N" primary lesions occur in nucleic acids, and that these primary events have only a minor responsibility for the oxygen effect. No such clear inference can be made in respect of primary events of "type O," which must have at least four to five times the probability of becoming lethal when oxygen is present during irradiation. It may be that "type O" events are associated with damage to "unit membranes" in the cell, but statistical difficulties arise. It may be envisaged that there is interaction between the consequences of primary "type O" events and some of the "type N" events, which would not be lethal without this interaction. It may be that the presence of oxygen affects the probability of lethal interaction, as well as the probabilities that "type N" and "type O" events are independently lethal. (UK)

28716 COMBINED LETHAL EFFECT OF ZINC CHLORIDE AND GAMMA IRRADIATION ON BACILLUS MEGATERIUM. Kiortsis, M. (Democritus Nuclear Research Centre, Athens). Nature (London), 217: 746-7(Feb. 24, 1968).

In the studies described Zn, combined with gamma irradiation, was shown to exert a synergistic inhibitory effect on the ability of B. megaterium to form colonies. The bacterial suspension was irradiated at room temperature with γ-rays from a 500 Ci ^{60}Co source, the dose rate being ~400 R/min given for 5 to 60 min. Survival curves of unirradiated samples containing various concentrations of $ZnCl_2$, of samples irradiated to different doses, and of irradiated samples containing Zn are shown. Heavy metals, in appropriate concentration, exert a deleterious effect on bacteria by combining with sulfhydryl groups which are essential to cell metabolism, and reagents that combine with sulfhydryls increase radiation sensitivity (at least in some micro-organisms). Combination of the two inactivating agents appears to affect both cell growth and cell multiplication. (UK)

28717 ULTRAVIOLET BACTERICIDAL IRRADIATION OF ICE. Ladanyi, P. A.; Morrison, S. M. (Colorado State Univ., Fort Collins). Appl. Microbiol., 16: 463-7(Mar. 1968).

The germicidal activity of 2537 A ultraviolet (uv) radiation on bacteria in ice cubes of varying thickness and in aqueous suspensions beneath an ice layer was investigated. The test bacteria used were Escherichia coli, Serratia marcescens, Bacillus subtilis, and Sarcina lutea; aqueous suspensions of the selected organisms were frozen into ice cubes, 2 mm to 30 mm thick, at −20°C. The cubes were irradiated for 1 min, whereas the suspensions of bacteria were placed beneath an ice block (19 cm thick) and were irradiated for 0.5 to 15 min. In both groups of experiments, the standard plate count method was used to compare the number of bacteria surviving the uv treatment with the number of bacteria in the untreated controls. The results showed that 1 min of uv treatment killed as many as 97% of the gram-negative and at least 60% of the gram-positive test bacteria (freezing survivors) frozen in ice cubes 30-mm thick. Within 15 min, uv light transmitted through a 19-cm thick ice block inactivated 98% of the bacteria suspended in the buffer solution. It was concluded that the uv rays were able to penetrate at least 19 cm of ice and still retain enough energy to kill bacteria. However, the uv penetration depended greatly on the optical quality of the ice. Although it was not the purpose of these experiments to find a practical method for sanitizing ice, the results of this study and of other unpublished

experiments indicate that uv light has adequate penetrating power to be considered practical in certain selected applications. (auth)

28718 STUDIES ON THE BACTERICIDAL EFFECT OF γ RAYS ON BRUCELLAE AND E. COLI. Genov, Iw.; Dimitrov, D.; Antonov, N.; Fjodorov, V. (Veterinary Inst., Sofia). Zentralbl. Bakteriol. Parasitenk., Abt. 1 Orig., 204: 563-8(Nov. 1967). (In German).

Studies were conducted with Brucella and Escherichia coli cultures exposed to γ rays to follow the bactericidal effect, development of L-transformed forms, and the succinic dehydrogenase activity. The cultural resistance depended on the dose of radiation which varied for the two microorganisms. For the E. coli strains, the bactericidal effect appeared with 300,000 R and for Brucellae complete inactivation was observed with 600,000 R. At lower doses, L-transformed forms developed. The morphological changes in the L-transformed forms were studied by light and electron microscopy. These investigations showed that within the limits of bacteriostatic doses the succinic dehydrogenase activity remained nearly unaltered, but changes were recorded at bactericidal dose levels. (BBB)

28719 THE ULTRAVIOLET PHOTOCHEMISTRY AND PHOTOBIOLOGY OF VEGETATIVE CELLS AND SPORES OF BACILLUS MEGATERIUM. Donnellan, J. E. Jr.; Stafford, R. S. (Oak Ridge National Lab., Tenn.). Biophys. J., 8: 17-28(Jan. 1968).

The formation of photoproducts by uv irradiation of spores and vegetative cells of B. megaterium was studied. The response of vegetative cells of B. megaterium appeared qualitatively similar to those of Escherichia coli, Micrococcus radiodurans, and B. subtilis with respect to photoproduct formation and repair mechanisms. Ultraviolet radiation, however, did not produce cyclobutane-type thymine dimers in the DNA of spores, although other thymine photoproducts were produced. The photoproducts did not disappear after photoreactivation, but they were eliminated from the DNA by a dark-repair mechanism different from that found for dimers in vegetative cells. Irradiations performed at three wavelengths produced the same amounts of spore photoproduct and gave the same survival curves. Variation of the sporulation medium before irradiation resulted in comparable alterations in the rate of spore photoproduct production and in survival. (BBB)

28720 INACTIVATION OF YEAST CELLS BY X-IRRADIATED BUFFERS. Laskowski, Wolfgang; Jannsen, Sigrid (Freie Univ., Berlin). Z. Naturforsch., 22: 686-7(June 1967). (In German).

Yeast cells were placed in a buffer solution containing KH_2PO_4 and EDTA. Experiments were conducted to determine effects of various doses of x radiation on yeast cells in buffer solutions and effects of irradiated buffer solutions on yeast cells. Graphs are presented to show results. No inactivation of yeast cells resulted from irradiation of buffer alone. (H.L.W.)

28721 EXPERIMENTAL-GENETIC INVESTIGATION ON LYSOGENIC BACTERIA DURING FLIGHT OF THE ISZ KOSMOS-110. Zhukov-Verezhnikov, N. N.; Volkov, M. N.; Maiskii, I. N.; (and others). Kosm. Issled., 6: 144-?(Jan.–Feb. 1968). (In Russian).

In experiments on Kosmos-110 using the lysogenic bacteria, Escherichia coli K-12, the statistics of the authentic mutations of moderate bacteriophage were determined. The quantity of the bacteriophage was given as a function of the increase of the duration of the flight. This is connected with the variation of the inducible bonds of the lysogenic bacteria and with the decrease of the range of the yield of the phages in one bacterial cell. With other tests (length of the latency period, character of the formation of phage components), a substantial difference between test and control colonies did not appear. The results of the investigation of the protective properties of chemical compounds of different classes under space-flight conditions in Kosmos-110 confirmed the height antimutation activity of preparations of the aminothiol group. (tr-auth)

28722 MUTATIONAL SYNERGISM BETWEEN HEAT AND SUBLETHAL DOSAGES OF ULTRAVIOLET LIGHT IN ESCHERICHIA COLI STRAINS. Sideropoulos, Aris S.; Johnson, Robert C.; Shankel, Delbert M. (Univ. of Kansas, Lawrence). J. Bacteriol., 94: 1486-8(Apr. 1968).

The fact that heat alone did not increase the spontaneous rate of mutation to streptomycin resistance in Escherichia coli B/r,, but that it did so when used in conjunction with low dosages of uv in E. coli B/r, but not in E. coli Bs-1, suggests that heat treatment probably caused partial inactivation of the dark-repair mechanism E. coli B/r. This impairment of repair may have produced the increase in mutant numbers. (auth)

28723 THE EFFECT OF ULTRAVIOLET AND VISIBLE LIGHT ON INFECTION OF HOST LEAF TISSUE BY FOUR SPECIES OF ASCOCHYTA. Blakeman, J. P. (Univ. of Aberdeen, Scotland); Dickinson, C. H. Brit. Mycol. Soc. Trans., 50: 385-96(1967).

The effect of white light and long (3500 Å) and short wavelength (2537 Å) uv light on spore germination, penetration, and infection was determined for Ascochyta chrysanthemi on chrysanthemum, A. pisi, and A. pinodes on pea, and A. imperfecta on lucerne, by means of a detached leaf culture technique. White light and long wavelength uv light had no effect on these processes. Short periods of exposure to short wavelength uv light resulted in increased infection, which was most marked in A. chrysanthemi and A. imperfecta, while longer exposures (up to 200 sec) caused a progressive reduction in infection and spore viability. The increased infection by A. chrysanthemi was due to an increase in the susceptibility of the leaf tissue as a result of exposure to short wavelength uv light. The response of A. chrysanthemi on irradiated leaf tissue of other plants was also altered; the susceptibility of lettuce was increased and the partial resistance of sunflower was destroyed. Spores of all four species survived the effects of short wavelength uv irradiation better on leaf tissue than on agar, and only spores of A. chrysanthemi showed a stimulation in germination on leaf tissue after short periods of exposure to uv light. There was no alteration in the growth rate of colonies which had developed from spores on agar which had survived irradiation by any of the three light sources. (BBB)

Radiosterilization and Radiopreservation

Refer also to abstract 27823.

28724 PASTEURIZATION OF FRESH RASPBERRIES WITH GAMMA RAYS OF DIFFERENT INTENSITY. Kudryasheva, A. A.; Medvedskaya, I. G. (All Union Scientific Research Inst. of the Canning and Vegetable Drying Industry, Bogucharovo, USSR). Vop. Pitan., 25: No. 3, 58-61(1966). (In Russian).

Containers of freshly picked raspberries were γ-irradiated (^{60}Co) with 3×10^3 and 4×10^3 rad doses at an intensity of 23 rads/sec or 150 rads/sec. Microorganism contamination of the berries was determined immediately before and after γ-irradiation by culture growth methods. Irradiated and control raspberries were stored at 5° and 20°. Results show that microorganism contamination is extremely high prior to irradiation; several million microorganisms were found per gram of berries with the following distribution: yeast organisms (80%), molds (12%), and bacteria (8%). Gamma irradiation significantly reduced microorganism contamination depending on irradiation dose intensity. A 300,000 rad dose at an intensity of 150 rad/sec reduces contamination to a mean of 93,000 organisms per gram of berries; but, the same dose at an intensity of 23 rads/sec reduces contamination to only 890,000 microorganisms per gram of berries. Gamma-irradiation doses of 5×10^3 rads/sec produced discoloration of berries. Gamma radiation doses of 3×10^3 and 4×10^3 rads/sec at an intensity of 150 rads/sec prolong the storage of raspberries by one to two days at 20°C and by three to four days at 5°C compared to the same doses at an intensity of 23 rads/sec. (JPRS)

28725 STERILIZATION WITH γ RADIATIONS. Steiger, E.; Suckow, W. (Humboldt Univ., Berlin). Wiss. Z. Hunboldt Univ. Berlin, Math.-Naturwiss. Reihe, 16: 197-200(1967). (In German).

Compared to β irradiation, the greater penetrability of γ irradiation offers a big advantage for sterilization of various materials. Effects of γ irradiation were tested on three types of soil spores at values of 306×10^3, 299×10^3, and 68×10^3 spores at thicknesses of about 0.15 mm. The maximum energy of the γ irradiation was about 2.8 MeV, with an average energy of 0.7 MeV, and a dose rate of about 10^4 R/hr. The vertical intensity followed a cosine distribution. After irradiation at the center of the beam with 1.01 to 1.50 Mrad, 50% of the samples were not sterile. After irradiation with 1.51 to 2.00, or 2.01 to 2.50 Mrad, the unsterile samples amounted to 25.7 and 22.2%, respectively. After exposure to an irradiation dose of from 2.51 to 5.50 Mrad all of the samples were sterile. The calculated lethal dose for the spore samples irradiated was between 1.98 and 2.50 Mrad. For practical use, the lethal dose necessary for sterilization of medical materials could be taken as 2.75 Mrad. (BBB)

28726 COMPARATIVE STUDY ON DECONTAMINATION OF MIXED FEEDS BY RADICIDATION AND BY PELLETISATION. Mossel, D. A. A. (Central Inst. for Nutrition and Food Research, Zeist, Netherlands); van Schothorst, M.; Kampelmacher, E. H. J. Sci. Food Agr., 18: 362-7(Aug. 1967).

Feed components contaminated with Salmonella act as vehicles in the transmission of these bacteria to animals and hence to meat and poultry. Sanitary improvements in processing, bagging and storage do not always effectively reduce Salmonella contamination rates and therefore ingredients or mixed feed should be decontaminated at the end of processing. Enumeration of Enterobacteriaceae was used to assay the decontamination effect of pelletization of mixed feed. A working temperature over 80° usually reduced the bacterial count by a factor of 10^5; lower temperatures currently used, reduced it by a factor of 10^3 only. In similar dose-range finding tests on decontamination with ^{60}Co γ rays, about 0.5 Mrad were required for reductions in the counts of the most resistant Enterobacteriaceae by a factor of 10^5. Survival curves being usually non-linear, gross effective dose had to be used as a parameter. Neither loss of nutritive value nor the occurrence of orally toxic factors was observed when rats were fed for two-years on a ration containing 35% fishmeal irradiated at 0.8 Mrad. A combination of improved sanitation, pelletizing at the highest possible temperature and, if still required, terminal low-dose irradiation of the hermetically bagged material seems, therefore, a promising approach to the manufacture of Salmonella-free feeds. (auth)

28727 FOOD IRRADIATION AND ITS FUTURE PROSPECTS. MacQueen, K. F. (Atomic Energy of Canada, Ltd., Chalk River, Ont.) Int. At. Energy Agency Bull., 9: 28-39(Dec. 1967).

The world food problem is surveyed in terms of production and population pressures. Among possible solutions is improvement of preservation, storage, and distribution of produced food. The useful preservation effects of radiation and their potential international application for a variety of foods is reviewed. The status of wholesomeness studies is discussed and recommendations are made concerning future developments in food irradiation. (C.O.)

METALS, CERAMICS, AND OTHER MATERIALS

Metals and Alloys

Refer also to abstracts 27964 and 30155.

28728 BRITTLENESS OF CRYSTALLINE SOLIDS. Conrad, H. pp 93-119 of Fragilite et Effets de l'Irradiation. 10e Colloque de Metallurgie, Saclay, France. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay. Paris, Presses Universitaires de France, 1967.

From 10th Symposium on Special Metallurgy Brittleness and Irradiation Effects, Saclay, France. See CONF-660656.

Brittleness in crystalline solids is reviewed from both an atomistic and macroscopic viewpoint. The various forms of brittleness are described and defined. The role of the following factors in brittleness is considered: nature of atomic bonding, dislocation mechanisms, defect structure, stress state, specimen geometry, surface environment, temperature and strain rate. The application of fracture mechanisms to semi-brittle materials is briefly discussed. (auth)

28729 PLUTONIUM PRODUCTION AND USE IN THE EURATOM COUNTRIES, GREAT BRITAIN, AND THE USA. Meyer, P.-J.; Ziegler, A. (Siemens AG, Erlangen, Ger.). Atomwirt., Atomtech., 13: 85-90(Feb, 1968). (In German).

A study was conducted of plutonium production to 1975 in the power reactors in operation, under construction or planned in Western Countries. Estimates are made of the plutonium needs which arise from those countries' programs for fast breeder reactors. This balance for the individual countries reveals a different but collectively very considerable demand. The gap between indigenous production and need is largest in the German Fedral Republic. In order to secure even a minimum coverage of the German need, plutonium must be bought from abroad. Because of the strong demand in the next few years the selling price will initially be relatively high but it will finally fall to at least the equivalent price for ^{235}U. The plutonium demand for fast breeder development should be fully covered by about 1975. The only possibility of commercial exploitation of plutonium will then be re-cycling in thermal converters. This will, however, only be economic if the price is lower than $5 per gram as compared with the current USAEC selling price of $40 to 43 per gram. The surplus must therefore lead to a lowering of price to this value. As a result of these considerations it appears prudent in the case of German demand to cover initially only the absolute needs until the end of 1968 and to postpone for as long as possible the purchase of plutonium for later demands. (auth)

28730 PRODUCING EXTREMELY FINELY-DIVIDED METALLURGICAL POWDERS. (to Cabot Corp.). British Patent 1,110,386. Apr. 18, 1968. Priority date June 17, 1964, United States.

Finely divided metalliferous powders are produced by thermal treatment of heat convertible chemical compounds of the metals previously blended with carbon black of high surface area. The slurry is subdivided into fine droplets by spraying and heated to remove volatiles. It is then treated in an oxidizing or reducing atmosphere to produce oxide or metal powders. The process is adapted to production of ultra-fine particles of alloys, free metals, titanium dioxide, carbides, metal-oxide compositions, and others, more rapidly and at lower temperatures than processes normally use. (P.G.C.)

Corrosion and Erosion

Refer also to abstracts 27529 and 27635.

28731 (ANL-6982) AN EXPLORATORY STUDY OF THE BEHAVIOR OF NIOBIUM- AND VANADIUM-BASE ALLOYS IN OXYGEN-CONTAMINATED SODIUM. Levin, Harry A.; Greenberg, Sherman (Argonne National Lab., Ill.). Jan. 1968. Contract W-31-109-eng-38. 20p. Dep. CFSTI.

Niobium- and vanadium-base alloys were exposed to oxygen-contaminated sodium at 650°C in a series of exploratory studies. The purpose of these studies was to determine if, based on corrosion (i.e., weight-change) data, any alloys in these systems may be suitable as fuel jacketing in sodium-cooled reactors operating at approximately 650°C. The tests of the niobium and vanadium alloys showed that vanadium alloys have markedly superior corrosion resistance. At oxygen concentrations below approximately 15 ppM, V-20 wt% Ti was the best alloy tested. (auth)

28732 (CEA-N-816, pp 102-39) ETUDES DE CORROSION. (Corrosion Studies). (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). (In French).

Developments are reported for studies on: physico-chemistry of nuclear materials corrosion; effects of graphite coupling on corrosion of stainless steels in nitric medium; effects of carbon on intergranular fissuration of Inconel 600 under stress in demineralized water at high temperature; stainless steels and nickel alloys; behavior of zirconium alloys in water and superheated steam; light alloys; corrosion of austenitic alloys Fe-Cr-Ni in water and steam at high temperature; and fuel elements storage. (P.C.H.)

28733 (DP(NASA)-941) STRESS CORROSION CRACKING OF TITANIUM ALLOYS. Progress Report, July 1-September 30, 1964. Rideout, Sheldon P.; Louthan, McIntyre R. Jr.; Selby, Clifford L. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Dec. 1964. Contract AT(07-2)-1. 22p. Dep. CFSTI.

Work was continued to determine the mechanism of stress corrosion cracking of titanium alloys exposed to hot chloride salts. Metallographically polished strips of Ti-8Al-1Mo-1V alloy that were stressed to the yield point at 650°F cracked within 3.5 hours with a maximum depth of 0.022 inch after 14 days. A heavy oxide film appears to inhibit cracking. Additional evidence was obtained indicating that HCl gas and presumably NaOH are formed during dehydration of sea salt; either or both may be involved in the corrosion. Oxides formed at 900 and 1100°F on 8-1-1 alloy are enriched with aluminum. Cracking may involve selective attack of this alloying element by NaOH or NaCl. Of the four principal chlorides in sea salt, NaCl and KCl used individually caused much more cracking than $MgCl_2$ or $CaCl_2$. The difference may be related to the relative strengths of the hydroxides of the cations. Radiotracers ^{22}Na and ^{36}Cl in sea salt are being used to study the roles of sodium and chlorine in the corrosion reactions. Traces of both were detected on cracked samples. Transmission electron microscopy studies of the Ti-8Al-1Mo-1V alloy were continued. (auth)

28734 (DP(NASA)-961) STRESS CORROSION CRACKING OF TITANIUM ALLOYS. Progress Report, October 1-December 31, 1964. Rideout, Sheldon P.; Louthan, McIntyre R. Jr.; Selby, Clifford L. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Mar. 1965. Contract AT(07-2)-1. 28p. Dep. CFSTI.

Results are described for the third quarter of research on the mechanism of hot-salt stress corrosion cracking of the Ti-8Al-1Mo-IV alloy. Initiation of stress corrosion cracking by chemical, rather than mechanical, action was indicated by corrosion of alpha-beta phase boundaries in polished, unstressed specimens exposed to NaCl at 650°F for one hour. Very slow cooling from the annealing temperature (1450°F) increased susceptibility to stress corrosion cracking, possibly because of segregation of alloy or impurity elements. "Self-stressed" samples cracked within 24 hours in anhydrous HCl gas at 650°F. Tests with radiotracers ^{36}Cl and ^{22}Na showed that chloride ions are readily adsorbed on the alloy surface at room temperature and apparently are absorbed into the oxide on heating. Sodium was not adsorbed, and was retained only at spots where salt adhered due to salt-metal reaction. Aluminum in the alloy appears to be selectively corroded during attack by NaCl at 650°F. Chloride salts are not unique in causing cracking. Both sodium iodide and sodium bromide caused initiation of cracking within 3 days at 650°F. Electron microscopy studies revealed that hydrogen was charged into the foils during thinning, resulting in precipitation of titanium hydride on the $\{10\bar{1}0\}$ planes. Hydride precipitation was particularly noticeable near grain and phase boundaries, suggesting a higher affinity for hydrogen in these regions. (auth)

28735 (EURAEC-2010) IN-PILE CORROSION OF NUCLEAR MATERIALS. Final Report. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)). [1968]. Contract 055-65-3 TEEB. 73p. (EUR-3796). Dep. CFSTI.

Work Performed under United States-Euratom Joint Research and Development Program.

Electrochemical corrosion tests were carried out on stainless steels, Al, and Pt under in-pile and out-of-pile irradiated solution conditions. The irradiations used a neutron flux of $>10^{12}$ nv and a gamma flux of $>5 \times 10^5$ R/hr. The results confirm the hypothesis that the corrosion behavior is determined largely by radiolytic effects in the solutions. The action of radiation is similar to

other means of provoking passivity, activation, or pitting. It is suggested that a Pt or steel electrode be used as a corrosion monitor in irradiated aqueous media. (D.L.C.)

28736 (KAPL-M-6748) THE EFFECTS OF SILICA IN AUTOCLAVE TEST WATER ON THE STEAM CORROSION OF ZIRCALOY. Callahan, E. J.; Kabat, J. F. (Knolls Atomic Power Lab., Schenectady, N. Y.). Jan. 30, 1968. Contract W-31-109-eng-52. 15p. Dep. CFSTI.

XE-150 resin is used to deionize autoclave water. In the spent state, XE-150 resin releases silicate ion to the test water resulting in the accelerated corrosion of Zircaloy. At a silicon concentration of 0.12 ppM, the 14-day weight gains of sensitized Zircaloy in 750°F steam are effected. At a silicon concentration of 1.3 ppM, the 14-day weight gains of reactor-grade Zircaloy in 750°F steam are effected. (auth)

28737 (USNRDL-TR-68-26) ELECTROCHEMICAL CORROSION STUDIES OF GALVANICALLY COUPLED SNAP-21 MATERIALS. Kubose, D. A.; Cordova, H. I. (Naval Radiological Defense Lab., San Francisco, Calif.). Jan. 15, 1968. 42p. Dep. CFSTI.

Electrochemical corrosion rate measurements on materials used in the SNAP-21 radioisotopically-fueled power system were made in seawater at room temperature. The materials examined included aluminum, copper, Hastelloy C, Hastelloy X, nickel, 304 stainless steel, tantalum, titanium-621 alloy and uranium-8% molybdenum alloy. The normal corrosion rate of each material was measured by means of galvanostatic polarization techniques. A galvanic series of the materials in seawater was determined and the galvanic currents between galvanically coupled materials were measured with a zero-resistance ammeter circuit. The effect of galvanic coupling of construction materials of the SNAP-21 system does not materially change the containment time of the ^{90}Sr fuel in the corrosive seawater environment. (auth)

28738 (WAPD-TM-619) THE CORROSION AND HYDROGEN ABSORPTION CHARACTERISTICS OF ZIRCONIUM ALLOYS CONTAINING 2.5 PERCENT TIN AND ADDITIONS OF IRON, CHROMIUM, AND NIOBIUM. Kass, Stanley (Bettis Atomic Power Lab., Pittsburgh, Pa.). Feb. 1968. Contract AT(11-1)-Gen-14. 50p. Dep. CFSTI.

The corrosion and hydrogen absorption characteristics of zirconium base alloys containing 2.5% tin in high temperature water and steam were studied. All alloys exhibited higher strength characteristics, without losses in ductility, than did the Zircaloys. Three alloys showed very low hydriding tendencies after exposure to high temperature water. (auth)

28739 MICROGRAPHIC STRUCTURE OF LAYERS OF OXIDE FORMED IN THE COURSE OF THE OXIDATION OF A SOLID MASS OF ZIRCONIUM. Debuigne, Jean; Lehr, Pierre (Centre d'Etudes de Chimie Metallurgique, Vitry-sur-Seine, France). Compt. Rend., Ser. C, 266: 903-5(Mar. 18, 1968). (In French).

The fibrous structure of layers of zirconia formed by the oxidation of zirconium was studied as well as their behavior during the course of thermal treatments at high temperatures. (tr-auth)

28740 OXIDATION OF TUNGSTEN AND RHENIUM UNDER LOW PRESSURE. Cassuto, Albert; Mihe, Jean-Pierre (CNRS, Nancy). Compt. Rend., Ser. C, 266: 863-6(Mar. 18, 1968). (In French).

The yield of the oxidation of tungsten and rhenium were measured in the range between 1400 and 2500°K for oxygen pressures varying between 5×10^{-6} and 3×10^{-4} torr. The curves pass through a maximum dependent on the pressure because of the production of atomic oxygen at high temperature (>2000°K). These confirm the same types of equations which implies an analogous oxidation mechanism. (tr-auth)

28741 ADSORPTION OF RADIOACTIVE CATIONS AND ANIONS ON STEEL SURFACES. Walton, G. N.; Hesford, E.; Williams, J. M. pp 15-37 of La Chimica dell'Acqua nei Reattori Nucleari. Rome, Comitato Nazionale Energia Nucleare, 1966.

From Symposium on Water Chemistry in Reactors, Rome. See CONF-213.

Measurements were made of ^{137}Cs and ^{36}Cl deposition on steel surfaces in water loops. The principal surface coverings were assumed to be α-FeOOH, $Fe(CH)_2$, and Fe_3O_4. Results are given in tables and are considered on the basis of two processes: electrolytic corrosion and ion exchange or adsorption. (M.C.G.)

28742 ANALYSIS OF THE RATE OF METALLIC URANIUM OXIDATION PROCESS AS FUNCTION OF THE TEMPERATURE. Bessonov, A. F.; Vlasov, V. G. (Ural Polytechnic Inst., Sverdlovsk, USSR). Zh. Fiz. Khim., 42: 900-2(Apr. 1968). (In Russian).

The changes in the activation energy and the rate of metallic uranium oxidation were studied in the air at 250 to 760°C, in oxygen at 250 to 400°C, and in carbon dioxide at 500 to 1000°C. The causes inducing the changes in the energy of activation were analyzed. (R.V.J.)

28743 HERALD RESEARCH REACTOR WATER TREATMENT AND CORROSION. Molineaux, H. F.; Jackson, E. W. pp 39-56 of La Chimica dell'Acqua nei Reattori Nucleari. Rome, Comitato Nazionale Energia Nucleare, 1966.

From Symposium on Water Chemistry in Reactors, Rome. See CONF-213.

Precautions considered necessary to minimize corrosion of the aluminum in the Herald reactor water system are considered. Specifications for the aluminum, chemical cleaning, addition of a corrosion inhibitor to the water, and water purity are discussed. Results are shown in tables and diagrams. (M.C.G.)

28744 O_2 AND CO INTERACTION WITH ALUMINUM FILMS GROWN ON Ta(110). Jackson, A. G.; Hooker, M. P.; Haas, T. W. (Systems Research Labs., Dayton, Ohio. Aerospace Research Labs., Wright-Patterson AFB, Ohio). Surface Sci., 10(May 1968).

The interactions of O and Co with Al structures grown on the Ta(110) surface were studied by low energy electron diffraction. Al(111) formed on the Ta(110) surface in two orientations at the proper substrate temperature. Two other structures appeared under varying conditions, the Al(111)c(2 × 2) and Al(100)c(2 × 2). A fifth phase formed at 900°C had no associated pattern. (P.G.C.)

28745 A STUDY OF OXIDE PLATE FORMATION IN TANTALUM. II. CRYSTALLOGRAPHIC ANALYSIS. Wayman, C. M.; Van Landuyt, J. (Univ. of Illinois, Urbana). Acta Met., 16: 815-22(June 1968). (COO-1198-488).

A detailed crystallographic analysis of TaO_y plates was made since observations indicated that the geometrical features of plate formation are like those of a martensitic transformation. The particular habit plane, orientation relationship, and (internal) twin plane variants were carefully determined, and the latter was used as input information for numerical calculations following the phenomenological theory of martensitic transformations. All experimental quantities such as the habit plane, orientation relationship, and magnitudes of the simple shear and shape deformation were in outstanding agreement with those theoretically predicted. The theoretical solution corresponding to the experimental results involves the smaller of the two magnitudes m_2 for the simple shear. Using a dilatation parameter range from 0.996 to 1.004, the best habit plane agreement was found for $\delta = 1.002$. In all respects the crystallographic features of the formation of TaO_y plates are in excellent quantitative agreement with corresponding theoretical quantities. The observed orthorhombic nature of TaO_y appears consistent with the occupancy of tetrahedral rather than octahedral interstitial sites, and this aspect as well as other related ones is discussed. (auth)

28746 A STUDY OF OXIDE PLATE FORMATION IN TANTALUM. I. GROWTH CHARACTERISTICS AND MORPHOLOGY. Van Landuyt, J.; Wayman, C. M. (Univ. of Illinois, Urbana). Acta Met., 16: 803-14(June 1968). (COO-1198-487).

A study by electron microscopy, electron diffraction, and optical microscopy is reported concerning the initial stages of the reaction of tantalum with oxygen. In tantalum sheets oxidized for short times (~10 min) at 500°C in oxygen at atmospheric pressure, the TaO_y orthorhombic suboxide phase was detected, which appears in the shape of plates in a layer near the surface highly enriched in oxygen. The orientation relationship between the parent and product phase was determined from electron diffraction. The plates have a {320} habit plane. An internal fine structure in the plates was identified as microtwins with a (101) twinning plane. A surface tilt associated with the plates was detected by two-beam interference microscopy. This result, together with the electron transmission and diffraction observations, and the results of a hot stage optical study strongly suggest that the transformation to TaO_y can be considered martensitic. Evidence was obtained that the controversy existing in the literature about the habit plane of the suboxide phases can be explained by the formation of a TaO_z overgrowth on top of the TaO_y plates. (auth)

28747 METHOD FOR MINIMIZING CORROSION OF REACTOR ELEMENTS. McHugh, William E.; Shoudy, Albert A. Jr.; (to Atomic Power Development Associates, Inc.). U. S. Patent 3,375,169. Aug. 23, 1966.

A method of minimizing the corrosion of a reactor element by removing the element from a reactor core and placing it in a tank of liquid is described. Then the element is treated with an electrolysis metal plating additive of nickel or chromium to form a corrosion resistant plating thereon, and then the element is transferred to a storage pool. (auth)

28748 BREAKAWAY AT CORROSION OF ZIRCONIUM. Ullrich, Georg (Eidgenoessische Institute fuer Reaktorforschung, Wuerenlingen, Switzerland). Z. Metallk., 59: 292-6(Apr. 1968). (In German).

The oxidation behavior of zirconium and its alloys follows a parabolic law when the oxide layer is protective. As soon as cracks appear, a deviation from this law is observed, and finally with more destruction of the oxide a linear curve—weight gain as function of time—replaces the parabolic law. This is called the breakaway. A calculation is made for the inelastic behavior of metal and oxide using the theory of superposition from Boltzmann and an assumed formula for a tensile stress in function of time in both metal and oxide. It is shown that the time for breakaway in function of the reciprocal, absolute temperature or of the argument $(1/\tau_1) \cdot \tau_2$ (τ_1 = time of relaxation in metal, and τ_2 such of the oxide, whereby the values of τ change with the Arrhenius equation) follows a curve, which is similar to that, when the internal friction Q^{-1} is graphed against the argument $\omega\tau$, (ω is the frequency for a periodic stress) or of the reciprocal, absolute temperature. (auth)

28749 STRESS CORROSION OF METALS. Logan, Hugh L. The Corrosion Monograph Series. New York, John Wiley and Sons, Inc., 1966. 316p. $13.95.

The phenomena and mechanisms of stress corrosion cracking of metals are discussed. Stress corrosion cracking of low carbon steels, low alloy steels for aerospace applications, stainless steels, copper base alloys, nickel alloys, aluminum alloys, magnesium alloys, titanium and titanium alloys, and precious metal alloy systems are discussed and techniques for eliminating stress corrosion failures are suggested. Methods of identifying stress corrosion failures and test methods that may be used for determining the susceptibility of metals to stress corrosion cracking are reported. (J.C.W.)

28750 SURFACE-FINISHING PROCESS FOR ZIRCONIUM AND ZIRCONIUM ALLOYS. (to Nukem Nuklear-Chemie Und-Metallurgie Gesellschaft mbH). British Patent 1,111,705. May 1, 1968. Priority date May 28, 1965, Germany.

A process for the production of a firm corrosion-resistant oxide layer on zirconium and zirconium alloys is given. The surfaces are pickled in a fluoride-containing solution, washed to remove residual fluorides, and rinsed in a current of steam and oxygen. (J.C.W.)

28751 IMPROVEMENTS IN OR RELATING TO THE PROTECTION OF MAGNESIUM OR MAGNESIUM ALLOYS. Sifferlen, Raymond (to Commissariat a l'Energie Atomique). British Patent 1,110,777. Apr. 24, 1968. Priority date July 9, 1964, France.

A method is given for protecting an article of pure Mg or low-alloy Mg for use as a structural material in gas-cooled reactors. The method comprises maintaining the article in a nitriding atmosphere (N_2 or NH_3) at a high temperature (>550°C, < melting point) for a time sufficient to form a superficial nitride layer on the article. An example of the application of the method is given in which Mg–0.6% Zr alloy tubes are nitrided for 120 hr to a layer thickness of <0.1 mm. (D.L.C.)

Preparation and Fabrication

Refer also to abstracts 27738, 27951, 27957, 27960, 28010, 30385, and 30389.

28752 (BNWL-SA-1806) METAL WORKING AND METAL FORMING TECHNOLOGY. Wick, O. J. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Apr. 22, 1968. Contract AT(45-1)-1830. 17p. (CONF-680425-2). Dep. CFSTI.

From Conference on Technology Utilization, Seattle, Wash.

A brief discussion is given of metal-working technology developed in the atomic energy program. The developments include glove box techniques, electron-beam welding, fabrication of complex shapes using filled billets, a cold-drawing lubricant, and adaption of conventional equipment to unconventional jobs. (D.L.C.)

28753 (CEND-3742-329) VANADIUM PURIFICATION. Quarterly Progress Report No. 5, October 1–December 31, 1967. Wang, C. T.; Chang, Wah; Barock, E. F.; La Vake, J. C.; Christopher, S. S. (Combustion Engineering, Inc., Windson, Conn. Nuclear Power Dept.). Jan. 1968. Contract AT(30-1)-3742. 14p. Dep. CFSTI.

Aluminothermic reduction of V_2O_5, followed by electron beam melting was used to produce high purity V for use in a V–Cr–Ti-base alloy. Chemical and hardness data on ingots produced during the experiments are tabulated. It was concluded that one of the major limitations to production of a suitable grade of V was the quality of V_2O_5 available. (P.G.C.)

28754 (LA-3911) ADDITION OF RARE EARTHS TO URANIUM AND URANIUM ALLOYS. Jaynes, G. E. (Los Alamos Scientific Lab., N. Mex.). Apr. 1968. Contract W-7405-eng-36. 20p. Dep. CFSTI.

The rare earths thulium, lutetium, and yttrium were added to uranium and uranium alloys in the range of 0.1 to 0.3 wt %. Nickel, cobalt, and rhodium were used as carrier metals for the rare earths. These carrier metals are partially soluble in uranium and also exhibit partial solubility for the rare earths. The room temperature tensile strength, yield strength, elongation, calculated modulus, and hardness were obtained for both as-rolled and vacuum-annealed sheet stock. Grain size, hardness, and density values were obtained on the as-cast alloys for comparison. (auth)

28755 (NASA-SP-5084) MACHINING AND GRINDING OF ULTRAHIGH-STRENGTH STEELS AND STAINLESS STEEL ALLOYS. Olofson, C. T.; Gurklis, J. A.; Boulger, F. W. (Battelle Memorial Inst., Columbus, Ohio). [Oct. 1965]. Contract DA-01-021-AMC-11651(Z). 216p. Dep. CFSTI.

The state of the art of metal-removal operations for stainless and ultrahigh-strength steels is discussed. The methods currently employed for conventional machining, grinding, electrolytic, electric-discharge, and chemical-machining processes are described. The precautions that should be taken to avoid troubles resulting from the characteristics typical of these alloys are pointed out. Nine machining, two grinding, two cutting, and three unconventional metal-removal operations are discussed separately. The classification of these alloys and their general response to machining variables are also discussed. 137 references. (auth)

28756 (NASA-SP-5088) DEFORMATION PROCESSING OF PRECIPITATION-HARDENING STAINLESS STEELS. Strohecker, D. E.; Gerds, A. F.; Boulger, F. W. (Battelle Memorial Inst., Columbus, Ohio). Oct. 1965. Contract DA-01-021-AMC-11651 (Z). 277p. Dep. CFSTI.

The state of the art is reviewed of both primary and secondary fabrication methods for precipitation-hardenable stainless steels. Methods currently employed for primary fabrication of these alloys include rolling, extrusion, forging, and drawing of tube, rod, and wire. Secondary metalforming operations are those processes that produce finished or semifinished parts from sheet, bar, or tubing using additional metalforming operations. The following secondary forming processes are discussed: brake bending, deep drawing, spinning and shear forming, drop hammer, trapped rubber, stretch, roll forming, dimpling, joggling, and sizing. Equipment and tooling used for the various operations are discussed and illustrated. 106 references. (auth)

28757 (UCRL-13341) QUARTERLY PROGRESS REPORT NUMBER 14 [ON METALLURGY], APRIL 1, 1964–JUNE 30, 1964. (Bureau of Mines, Albany, Oreg. Albany Metallurgy Research Center). June 1964. Contract W-7405-eng-48. 26p. Dep. CFSTI.

For Univ. of California Lawrence Radiation Lab., Livermore.

The project established to provide melting services for Lawrence Radiation Laboratory is decribed and data on composition of U-base alloys prepared under the project are tabulated. Methods of fabricating experimental U alloys and determining their properties are described. Selected mechanical properties of Re and Re-base alloys are tabulated. Results of studies on preparation of W–25% Re alloys by H_2 reduction of mixed chlorides or mixed ammonium salts are included. (J.R.D.)

28758 (Y-1613) RESISTANCE SPOT WELDING STAINLESS STEEL FOIL BY THE EXPENDABLE-WIRE TECHNIQUE. Estes, C. L. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). Apr. 19, 1968. Contract W-7405-eng-26. 17p. Dep. CFSTI.

A spot welding method, which consists of placing an expendable copper wire between the workpiece and the electrode of the resistance spot welder, has been developed, demonstrated, and evaluated. This technique eliminates the need for electrode dressing, produces elongated spot welds that reduce the number of individual welds needed, and can be used at locations that are very close to the edges of the workpiece. (auth)

28759 ALLOY ADDITION AGENTS FOR VACUUM MELTING. Brown, C. M. (Union Carbide Corp., Niagara Falls, N. Y.; Vogt, J. R. J. Metals, 20: 75-80(May 1968).

Alloy addition agents for use in vacuum melting were developed that are low in the gaseous elements and in tramp metallic elements that contribute to undesirable properties in the final composition. High purity alloying agents for elements such as Cr, W, Nb, Ta, Mo, V, Zr, and B are available commercially. In addition to the overall control of hot chemical analysis, illustrations are given to show that a high degree of chemical uniformity is found even in small use increments. It was also shown that for elements like W and Nb which previously were considered difficult to dis-

solve, the high purity, or vacuum quality, addition agents offer significantly higher rates of solution. These characteristics assist the vacuum melter to make high quality iron-, nickel-, cobalt-, and titanium-base alloy products. New processing and inspection techniques were developed particularly for addition agents used in the consumable electrode vacuum melting of titanium alloys. These methods are designed to maintain absolute cleanliness during processing and to assure the absence of undesirable impurities by 100% inspection of the commercial products. The techniques thus demonstrated pave the way for more sophisticated processing of other addition agents when the need develops. (auth)

28760 DIRECT REDUCTION OF URANIUM HEXAFLUORIDE WITH METALLIC CALCIUM AS A METHOD FOR THE PRODUCTION OF URANIUM METAL. Slivnik, J.; Smalc, A.; Zemljic, A. (Nuklearni Institut Jozef Stefan, Ljubljana, Yugoslavia). Vestn. Slov. Kem. Drus., 13: 5-8(Jan.-Dec. 1966). (In Slovak).

The method for direct reduction of UF_6 with metallic calcium in a closed reaction vessel is described. The metallic uranium was thereby obtained in one piece. (tr-auth)

28761 EVALUATION OF MODIFIED SOLIDIFICATION TECHNIQUES FOR GROWTH OF LARGE CRYSTALS OF Pu-3.3 AT. PERCENT GALLIUM ALLOY. Moment, R. L. (Dow Chemical Co., Golden, Colo.). Contract AT(29-1)-1106. J. Crystal. Growth, 2: 15-25(1968). (RFP-991).

Experiments are described in which large grains of the plutonium–3.3 atomic percent gallium alloy were grown using a modified Bridgman technique. After solidification from the melt, slow transformation between the epsilon and delta phases generally produced polygonized grains. Some specimens treated this way were given extensive anneals in the high delta region which resulted in a few large perfect grains being formed. The perfect grains were probably due to extensive grain growth. Other experiments in which specimens were quenched through the epsilon–delta phase transformation also produced large perfect grains. The process thought to be operative in this case is strain annealing in which the strain is caused by the volume change of the epsilon to delta transformation. Sharp back-reflection Laue photographs were obtained which verified the degree of perfection of these and other grains. (auth)

28762 HOT SHORTNESS OF α BRASS AND INFLUENCE OF URANIUM ADDITION. Sato, Shiro; Sagisaka, Kiyoji. Sumitomo Keikinzoku Giho, 9: 2-13(Jan. 1968). (In Japanese).

The hot working properties of α brass are severely impaired by the presence of some impurities of low mp such as Pb or Bi. An investigation was made on the deleterious effect of impurity elements (Pb, Bi, Sb, As) and the modifying effect of U on the hot working properties of α brass from the viewpoint of microstructural characteristics. Microscopic observations revealed the distribution of globule type of Pb and Bi, and that of film type of Sb or As compound. The ratios of interfacial energy of liquid metal and grain (γ_{LS}) to that of grain boundary (γ_{SS}) were 0.7 and 0.6, respectively, on Pb and Bi and less than 0.5 on Sb and As. The Charpy impact strength of specimens containing more than 0.002% Pb or 0.0004% Bi decreased rapidly at the temperature which coincided with the mp of Pb or Bi. However, in the free forging test, surface cracking was observed on the specimens containing more than 0.030% Pb or 0.007% Bi. The specimens containing Sb or As showed a gradual increase in hot shortness with increasing impurity content or temperature. The addition of a sufficient amount of U to the alloys was highly effective in reducing hot shortness by the formation of stable intermetallic compounds of UPb or UBi. (BBB)

28763 PRODUCTION OF TANTALUM METAL BY ALUMINOTHERMIC REDUCTION OF ITS PENTOXIDE. Gupta, C. K.; Jena, P. K. (Bhabha Atomic Research Center, Bombay). J. Metals, 20: 25-8(May 1968).

A method for obtaining massive tantalum metal through alumino–thermic reduction of its pentoxide by triggering the reaction with the help of a small amount of calcium and sulfur at a comparatively low temperature of about 450°C and using a suitable charge composition so as to form a low melting slag of Al_2O_3–Al_2S_3, was developed. On a 500-g scale using tantalum pentoxide, the yield was 88%. High purity, ductile tantalum metal was produced from this metal by the combination of nonconsumable arc and electron-beam meltings. The lower cost of the reductant, high yield, and some other experimental advantages of alumino-thermic reduction over calcium and magnesium reductions makes the process attractive. (auth)

28764 FABRICATION OF COMPLEX BERYLLIUM SHAPES BY GAS-PRESSURE COMPACTION. Hanes, H. D.; Gripshover, P. J.; Hodge, E. S. Planseeber. Pulvermet., 14: No. 3, 153-64 (Dec. 1966).

The gas-pressure-bonding process has been used as a technique for hot isostatically pressing Be powder into complex shapes. This process uses high inert-gas pressures to force the particles into intimate contact, and elevated temperatures to promote interparticle bonding. Because of the high pressure used, 10,000 to 15,000 psi, full densification can be achieved at 1400°F, thus maintaining a fine grain size in commercial powders. The isostatic pressure application allows the densification of complex configurations and machining operations are minimized. Be powder is preformed by vibratory packing, cold hydrostatic pressing, plasma-arc spraying, or explosive compaction. The preform is then loaded and sealed in an expendable, thin-gage, mild steel container. Internal cavities are formed by Cu or Ni mandrels, which are removed after gas-pressure compaction by selective leaching. Specimens with complex external surfaces are packed in a sodium chloride pressure-transmitting layer to allow canning in simple containers. A variety of Be shapes have been gas-pressure compacted by means of these techniques. Included are simple tubes and rods, duplex and fluted tubes and various gyro components. (Rev. Metal Lit.)

28765 ELECTRODEPOSITION OF NICKEL–TUNGSTEN ALLOYS FROM THE PYROPHOSPHATE BATH. Vasu, K. I.; Rama Char, T. L. Metal Finish. J. (London), 13: No. 145, 5-9; 13(Jan. 1967).

Alloy deposition was carried out under different electrolyte concentrations and with varying addition agents, pH, temperature and agitation in plating solutions prepared from nickel pyrophosphate, sodium tungstate, ammonium citrate and potassium pyrophosphate to show the effects of these variables on plate composition, cathode efficiency and cathode potential. The bath gave adherent and smooth deposits with 47 to 94% Ni, with color ranging from dull to bright white. Deposit composition did not vary with the plating time up to 120 min. Brightness of the plate was improved by additions of salts of Zn, Fe and Co and by sulfanilamide, p-hydroxyazobenzene, coumarin, and gelatin. The bath was stable under the experimental conditions. Coatings thicker than 0.0005 in. could be obtained and were resistant to corrosion in the laboratory atmosphere. Total metal content of the deposits was 99 to 100%. (Rev. Metal Lit.)

28766 ELECTRODEPOSITION OF COPPER–MOLYBDENUM ALLOYS. Krohn, Albertine; Bohn, Carole W. Plating, 54: 153-6(Feb. 1967).

Pyrophosphate solutions have been used for the successful codeposition of Mo with Fe, Co and Ni. The study of the electrodeposition of Cu-Mo alloys is especially intriguing. These alloys cannot be prepared by the usual metallurgical methods since Mo is insoluble in molten Cu. A study of the plating variables has shown that it is possible to deposit bright, adherent Cu-Mo alloys from an alkaline pyrophosphate bath. Such deposits contain about 87% Cu, 8% Mo and 5% O, and are deposited at about 52% cathode current efficiency. The deposits are light pink when freshly plated, but tarnish on standing. (Rev. Metal Lit.)

28767 PRODUCTION OF FERRONIOBIUM. Lyakishev, N. P.; Bogolyubov, V. A.; Ignatenko, G. F.; Pliner, Yu. L. Stal, No. 9, 712-13(Sept. 1966).

A comparison is made of three methods for producing ferroniobium: carbothermal, used mainly for reprocessing lean Nb-bearing concentrates and producing an alloy containing 22 to 37% Nb with Nb extraction of 98%; silicothermal production in an arc furnace which recovers about 70%; and the alumino-thermal method, both by electric furnace and by out-side-the-furnace means. The last method, electric furnace production, has been found to be the most productive. Gas content in the ferroniobium is four times less than in that produced outside the furnace. The alloy tapped from the furnace contains 50 to 55% Nb and separates easily from the slag upon cooling. Transfer of basic charge elements into alloy in electric furnace production is Nb, 95.5%; Si, 80%; Ti, 23%. Outside-the-furnace production shows 88, 80 and 65%. The aluminothermal method, using an arc furnace, ensures highest Nb recovery rate while maintaining a high quality of alloy and low Al consumption. (Rev. Metal Lit.)

28768 OBTAINING NEODYMIUM DIGERMANIDE. Lynchak, K. A.; Kosolapova, T. Ya.; Kuz'ma, Yu. B. (Inst. of Problems in Material Studies, Kiev). Porosh. Met., Akad. Nauk Ukr. SSR, No. 2, 54-6(Feb. 1968). (In Russian).

An investigation is carried out on the possibility of obtaining germanides of the rare-earth metals using the example of neodymium digermanide from germanium-thermal method. Exposure for 1 hour at 1400°C and pressure about 6 to 7.5×10^{-2} mm Hg are the optimum conditions for obtaining neodymium digermanide. With the higher vacuum in the system the lower germanide Nd_5Ge_3 is the product of the reaction. (auth)

28769 CANNING MATERIALS FOR WATER REACTORS. Edstrom, J. O.; Lagerberg, G. (Sandvik Steel, Sweden). Nucl. Eng., 13: 348-53(Apr. 1968).

The relevant properties and methods for fabrication of Zr alloys, austenic stainless steels, and Ni alloys are reviewed, and their advantages and limitations are discussed. (UK)

28770 IMPROVEMENTS IN OR RELATING TO METHODS OF PURIFYING BERYLLIUM. Potard, Claude; Schaub, Bernard (to Commissariat a l'Energie Atomique). British Patent 1,107,195. Mar. 20, 1968. Priority date Mar. 3, 1965, France.

Beryllium having a very low impurity content, particularly Fe, was prepared from a beryllic product by dissolving the beryllic product in a metallic solvent, effecting a first separation by filtration after fractional crystallization, and effecting a second separation from the Be-enriched residue of the metallic solvent containing substantially all the remaining impurities. The metallic solvent may be metallic Al or a liquid alloy of Al with at least one of the following elements: Si, Zn, and Mg. The second separation is preferably a selective chemical attack by a dilute mineral base, such as 20 wt % of dilute potash at 20°C. Alternately, the second separation may be extraction of the solvent by a metal. (B.L.M.)

28771 MATRIX-TYPE NUCLEAR FUEL ELEMENT INCLUDING FISSION PRODUCT RETENTIVE MATERIALS. Higatsberger, Michael J. (to Osterreichische Studiengesellschaft fur Atomenergie, GmbH). U. S. Patent 3,350,274. Oct. 31, 1967. Priority date Apr. 26, 1963, Austria.

A method is described which prevents fission products produced in fuel element irradiation from leaving the matrix. Silver, Be, Mo, Se, or Zr and their carbides, oxides and nitrides are added to the fuel element matrix or moderator material to bind the fission products into non-volatile materials. The fuel elements are not so susceptible to material defects or deficiencies during their production. Fission products are safely bonded by the sintered material even at high temperatures. (F.S.)

28772 PRESSURE BONDED CERAMIC-TO-METAL GRADIENT SEALS. (to United States Atomic Energy Commission). British Patent 1,110,706. Apr. 24, 1968. Priority date Mar. 26, 1965, United States.

A ceramic-to-metal seal is described in which limitations of service conditions due to metallizing and brazing materials are avoided. In this seal, the sealing region comprises a mixture of the refractory metal and ceramic, whose composition varies according to its proximity to the faying surfaces. The method of making the seal comprises disposing a series of powder layers of this mixture between the faying surfaces, and applying heat and pressure to sinter and bond the powder to the surfaces. As an example, the bonding of Nb to Al_2O_3 is discussed. (D.L.C.)

Properties Evaluations

Refer also to abstracts 27622, 27738, 27988, 28006, 28032, 28190, 28754, 30164–30167, and 30387.

28773 (AERE-R-5733) THE TENSILE DEFORMATION AT HIGH TEMPERATURES OF UNIDIRECTIONALLY GROWN AND POLYCRYSTALLINE ALUMINIUM–$CuAl_2$ EUTECTIC. Butcher, B. R.; Weatherly, G. C.; Pettit, H. R. (Atomic Energy Research Establishment, Harwell (England)). Feb. 1968. 22p. Dep. CFSTI. UK.

Tensile tests have been done at 300 and 500°C on specimens of unidirectionally grown aluminium – $CuAl_2$ eutectic of various orientations and at 300 and 400°C on polycrystalline samples of this alloy. The tensile results, deformation and failure mechanisms, and spheroidization phenomena are described and discussed. (auth)

28774 (AGN-8269) ALKALI METALS EVALUATION PROGRAM. Quarterly Progress Report, October 1–December 31, 1967. Achener, P. Y. (Aerojet-General Corp., San Ramon, Calif. Nuclear Div.). Feb. 1968. Contract AT(04-3)-368. 25p. Dep. CFSTI.

ALKALI METALS—thermodynamic and transport properties of program for measurement of

HEAT TRANSFER—analysis of laminar-flow, in circular tube with variable wall temperature (D.L.C.)

28775 (BARC-313) METHOD FOR DETERMINING THE THERMAL AND ATHERMAL COMPONENTS OF FLOW STRESS FROM STRESS RELAXATION. Rodriguez, P. (Bhabha Atomic Research Centre, Bombay (India)). 1967. 9p. Dep.

The values of thermal components of flow stress at various temperatures from yield and flow stress measurements and also from stress-relaxation experiments are presented. Annealed sheet specimens of polycrystalline Nb are used in the studies. Tensile tests are carried out at a strain rate of 6.67×10^{-5} per sec at temperatures from 77 to 448°K, using approximate temperature baths. Stress-strain curves are presented. (D.C.C.)

28776 (BAW-3765-6) CORROSION AND HYDRIDING OF ZIRCALOY. TASK 2 TOPICAL REPORT. EFFECTS OF HYDROGEN AND PRECIPITATED HYDRIDES ON MECHANICAL PROPERTIES OF ZIRCALOY-4. Lowe, A. L. Jr.; Johnson, C. R. (Babcock and Wilcox Co., Lynchburg, Va. Research and Development Div.). Mar. 1968. Contract AT(30-1)-3765. 61p. (EURAEC-1954). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

It was estimated that as much as 25 mg/dm^2 of the hydrogen released by corrosion could be absorbed during a 1000-day service life. This would amount to more than 500 ppM hydrogen in 25-mil cladding. Therefore, a program was conducted to determine the tensile properties of Zircaloy-4 tubing containing up to 1000 ppM hydrogen over a temperature range from 70 to 800°F. (1000 ppM hydrogen is an estimated possible local concentration under severe operating conditions, and 800°F corresponds to the calculated inside diameter temperature under peak operating conditions toward the end of the core life.) Burst tests of hydrided material were included, but these were limited to room-temperature testing. Annealed and cold-worked material from the same lot of Zircaloy-4 tubing was tested. Tensile tests were performed at six different temperatures (70 to 800°F) and six different hydrogen concentrations. The tensile-test results show that hydrogen has no significant effect on the tensile and yield strength of Zircaloy-4 over the 70 to 800°F temperature range. On the other hand, tensile elongation is reduced appreciably at temperatures below 300°F. Significant reductions in tensile elongation persist over the entire temperature range of interest when the hydrogen concentration is above 200 ppM. These results show that at operating temperatures, residual ductility measured by tensile elongation is consistently above 10% for cold-worked material containing as much as 1000 ppM hydrogen. However, at low temperatures, elongation values as low as 3% were measured, which indicates that post-operation handling of fuel elements will require care to avoid shock loading or imposed strains that could breach the cladding. The results of burst testing show that hydrogen reduces room-temperature (70°F) burst strength and ductility. Under the biaxial loading conditions of the test, the burst strength of cold-worked Zircaloy-4 tubing was reduced about 25% (from 115,000 to 85,000 psi) by adding 1000 ppM hydrogen to the test specimens. The burst strength of annealed tubing was reduced about 18% (from 88,000 to 72,000 psi) by the same hydrogen addition. Significant fragmentation of both the annealed and cold-worked tubing occurred on bursting; this indicates a low ductility and confirms the need for careful handling of hydrided fuel elements. (D.L.C.)

28777 (BMI-1837) PROGRESS RELATING TO CIVILIAN APPLICATIONS DURING JANUARY–MARCH 1968. Keller, Donald L. (Battelle Memorial Inst., Columbus, Ohio). Apr. 1, 1968. Contract W-7405-eng-92. 85p. Dep. CFSTI.

The effect of U_2N_3 on the sinterability of mechanically mixed PuN–UN powders and the effect of increased ball-milling time on powder sinterability were studied. Mechanically mixed UN and PuN resist sintering densification more than prealloyed nitride powders and increasing the ball-milling time from 32 to 64 hr increases sintered density very little. Arc melting and casting techniques for preparing single-phase or hyperstoichiometric mixed (U,Pu)CN fuels were studied and specimens in a series of fuels prepared from a charge with a 2.5 wt % C content were analyzed by chemical and metallographic techniques. The cyanogen process at 1000 to 1200°C was initiated to determine its feasibility as a method of nitride synthesis of UN, PuN, and (U,Pu)N. Determination of the plutonium activity in solid-solution (U,Pu)N was begun and weight-loss measurements were made at 2020, 2050, 2120, and 2130°K and the plutonium vapor pressures were calculated for these temperatures. A micro-Kjeldahl procedure was used for determination of nitrogen in (U,Pu)N. Results of these analyses show the effects of varying the order of contact with the dissolution medium on nitrogen content. Research on the compatibility of PuN–UN fuels with Types 304 and 316 stainless steels, ORNL stainless steel alloy, Inconel 625, and Incoloy 800 with sodium bonding is summarized. Thermal diffusivity measurements for (U,Pu)N at 300 to 1100°C were made. Linear thermal expansion of (U,Pu)N was measured at 20 to 1175°C. Four billets of UN were fabricated by hot pressing at 11,000 psi and 1850°C for use in testing the ability of liquid Na to wet UN. Four high-density and two low-density (U,Pu)N fuel samples were fabricated by sintering and clad in Type 304 stainless steel for irradiation testing. Irradiation testing of capsule was completed and 2 irradiation

tests continue. The temperature and burnup history of the capsules are tabulated. One capsule was discharged from the MTR after 12 irradiation cycles and swelling was estimated from neutron radiographs. Specimens of high-density sintered (U,Pu)N are being prepared for EBR-II irradiation. Construction of equipment to encapsulate the fuel pins has begun. Work on capsule assembly is progressing. Tensile tests were performed on irradiated specimens of Tenelon, UMCo-50, and Haynes Stellite 25 determine the extent of radioinduced changes in their properties for potential cladding materials for liquid-metal-cooled fast reactor applications. Electron-beam zone melting and controlled solidification techniques to produce single crystals of Type 347 stainless steel were investigated. The capsules have been assembled for EBR-II and ETR insertion to compare the effects of a predominantly fast-neutron flux and a mixed fast- and thermal-neutron flux on the mechanical properties of cladding materials. Fracture toughness of two WOL specimens machined from the PM-2A reactor vessel is being evaluated. PyC-coated-PuO_2 particles were prepared for evaluation for compatibility and irradiation testing. Experiments to determine the environmental conditions necessary to produce substoichiometric PuO_2 particles for coating and compatibility studies have continued. (J.C.W.)

28778 (COO-1198-500) THIRD ORDER ELASTIC CONSTANTS OF ALUMINUM. Thomas, Joseph F. Jr. (Illinois Univ., Urbana). Feb. 1968. Contract AT(11-1)-1198. 110p. Dep. CFSTI.

Thesis.

The complete set of six third-order elastic constants of single-crystal Al has been experimentally determined by measuring both hydrostatic pressure and uniaxial stress derivatives of the natural sound velocities using a two-specimen interferometric technique. The values obtained are $C_{111} = -10.76$; $C_{112} = -3.15$; $C_{123} = +0.36$; $C_{144} = -0.23$; $C_{166} = -3.40$; and $C_{456} = -0.30$ in units of 10^{12} dyn cm^{-2}. The specimens were neutron irradiated to eliminate dislocation effects from the uniaxial experiments. A self-consistent set of hydrostatic pressure derivatives of the second-order elastic constants has been calculated from the measured third-order elastic constants. The third-order elastic constants have also been used to calculate the thermal expansion in the anisotropic continuum model at both high and low temperatures, and a comparison has been made to the directly measured expansion coefficients. The seven independent relations between second- and third-order elastic constants and appropriate lattice energy derivatives in a Fuchs approach have been obtained. The related deformation parameters have been described in a consistent fashion. The applicability of the Fuchs approach to elastic constant calculations for metal crystals has been discussed in terms of the neglect of energy terms which depend upon volume only. An attempt has been made to calculate the second- and third-order elastic constants of Al in a Fuchs approach using a Wigner–Seitz decomposition of the lattice energy. The terms considered were the electrostatic energy and the Fermi energy. The Fermi energy was treated in a nearly free-electron approximation. The fact that this attempt was unsuccessful has been attributed to the complicated energy band structure of Al in the vicinity of the Brillouin zone boundaries. (auth)

28779 (NP-17422) UTILIZATION OF DEPLETED URANIUM. Summary Report for Research Ending June 30, 1960. (Bureau of Mines, Rolla, Mo. Rolla Metallurgy Research Center). 51p. Dep. CFSTI.

The possibilities of using depleted uranium as a constituent of bearing metals are explored. From a study of crystal habits and distributions in tin-base and lead-base alloys, it was learned that the compounds UPb_3 and USn_3 behave similarly to SbSn, which constitutes the hard phase in many of the common babbitt materials. It was found that particle size and distribution rates could be controlled by the use of normal care in the preparation of the babbitt. Less complete information was determined for copper–uranium alloys and the corresponding phase, UCu_5. On the basis of hardness, wear, and frictional tests, alloys of tin containing 5 to 25% uranium are superior in bearing properties to many commercially used babbitts. Lead–uranium alloys, on the other hand, are inferior in wear properties if the uranium content is below 8%, and their corrosion-resistant properties are low, especially if the uranium content is greater than 8%. (auth)

28780 (TID-24314(PT.1)) PROPERTIES OF SOME REFRACTORY METALS. I. ENTHALPY AND HEAT CAPACITY. Conway, J. B. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation). Feb. 25, 1964. Contract AT(40-1)-2847. 30p. (GE-TM-64-2-12). Dep. CFSTI.

Enthalpies and heat capacities of several refractory metals are reviewed. Existing compilations are presented and compared with more recent experimental determinations. Recent studies have identified slightly different enthalpy values particularly in the high temperature range above 2000°K. This is particularly true of heat capacity values where differences as high as 40% have been observed. Enthalpy values for all metals having melting points above 2000°C can be represented within ±5% by a single curve. A least squares expression for this enthalpy relation is presented. New enthalpy data for rhenium to 2250°C are presented and enthalpy data for the Mo–48Re alloy are shown to be in excellent agreement with data calculated by a simple weight fraction summation of pure metal enthalpies. The enthalpy curve for tungsten gives a good approximation for the enthalpies in the tungsten–rhenium and the tantalum–tungsten alloy systems. (auth)

28781 (TID-24314(Pt.2)) PROPERTIES OF SOME REFRACTORY METALS. II. THERMAL CONDUCTIVITY. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation). [1964]. Contract AT(40-1)-2847. 26p. (GE-TM-64-4-3). Dep. CFSTI.

The high temperature thermal conductivity data for several refractory metals have been reviewed and compared. In addition the techniques presently being employed in these measurements are also discussed and summarized. Many inconsistencies exist in the published thermal conductivity data for the refractory metals particularly in the temperature range above 1500°C. A curve has been drawn for the most representative data for these materials. Thermal conductivity data calculated through the use of the Lorenz number are also presented and compared with available experimental data. (auth)

28782 (UCRL-18063) ORIENTATION EFFECT ON THE PLASTIC DEFORMATION BEHAVIOR OF MOLYBDENUM SINGLE CRYSTALS AT LOW TEMPERATURES. Liu, Chih-an (California Univ., Berkeley. Lawrence Radiation Lab.). Mar. 1968. Contract W-7405-eng-48. 32p. Dep. CFSTI.

Thesis.

Single crystals of Mo oriented near the $[\bar{1}11][011]$ edge in the standard stereographic projection triangle were tested in tension at different temperatures from 20 to 600°K at a strain rate of 1.31×10^{-4} sec^{-1}. The results were compared with the data from deformation of Mo single crystals oriented at the center of the standard stereographic projection triangle for $(\bar{1}01)[111]$ single slip. Below about 440°K, the flow stress depends strongly on both the temperature and orientation. Experimentally determined activation volumes showed very good agreement with the Peierls mechanism but the activation energies did not. Analyses of the results revealed that the Dorn-Rajnak model of the Peierls mechanism may be reconstructed for dislocation core energies so as to explain the observed asymmetric behavior of single crystals of bcc metals. Analyses of the deformation traces show that specimens tend to slip crystallographically on the $\{\bar{1}01\}$ planes at low temperatures. The slip lines increase in waviness as the temperatures are increased. The slip direction is always consistent with the [111] direction for all temperatures. (auth)

28783 (TT-66-59003-4/A) MINING AND METALLURGY QUARTERLY. Translation of Rudarsko-Metalurski Zbornik, Suppl., No. 4/A: 553-636(1966). 94p.

Information is presented in articles on steel deoxidation using Si, determination of P in stainless steels and heat-resisting steels, reduction characteristics of Jesenice iron works blast furnace contents, thermodynamics of binary alloys and systems, determination of Sb in Fe ores, stabilization of $MgO-ZrO_2$ systems, nonmetallic inclusions in steel, case hardening of carburizing steels, flotation of chromites, and heat treatment of nickel steel. (J.R.D.)

28784 CALORIMETRIC MEASUREMENT OF THE HEAT OF SOLUTION OF SAMARIUM IN TIN. DETERMINATION OF THE ENTHALPY OF FORMATION OF DEFINITE COMPOUNDS IN THE SYSTEM TIN–SAMARIUM. Percheron, Annick; Mathieu, Jean-Claude; Trombe, Felix (CNRS, Grenoble, France. Centre National de la Recherche Scientifique, Bellevue, France). Compt. Rend., Ser. C, 266: 848-51(Mar. 18, 1968). (In French).

The heat of solution of samarium in tin was measured at 967°K. This made possible the determination of limiting partial enthalpy of samarium at 295°K, $\Delta H^{\infty}_{Sm} = -45.6$ kcal/mole. The heats of solution of the definite compounds of the system tin–samarium have also been determined. From this it is possible to deduce, taking into account the partial enthalpy of samarium, their heats of formation at 295°K in kilocalories per mole: $\Delta H_f(SmSn_3) = -53.8$; $\Delta H_f(Sm_2Sn_3) = -86.9$; $\Delta H_f(Sm_5Sn_3) = -121.7$. (tr-auth)

28785 INTERACTION OF ZINC WITH BERYLLIUM. Dubinin, V. A.; Lebedev, V. A.; Nichkov, I. F. (Ural Polytechnic Inst., Sverdlovsk, USSR). Zh. Fiz. Khim., 42: 678-81(Mar. 1968). (In Russian).

The activity of Be in liquid Zn solutions was measured by the emf method at 594 to 790°C. A marked positive deviation of the

activity from Raoult's law was established. During dissolution of Be in Zn, formation of a regular grouping in the melt was not observed. The process of dissolution was accompanied by heat absorption and increase of entropy. The solubility of Be in Zn agreed with the results of the direct determination. The equality of the potential of the Be-saturated Zn solution and metallic solution indicates the absence of intermetallic compounds in the Be–Zn system. (tr-auth)

28786 INVESTIGATION BY THE ELECTROMOTIVE FORCE METHOD OF THE THERMODYNAMICS OF LIQUID ZINC–URANIUM ALLOYS. Volkovich, A. V.; Nichkov, I. F.; Raspopin, S. P.; Titarenko, V. I.; Lebedev, V. A. (Ural Polytechnic Inst., Sverdlovsk, USSR). Zh. Fiz. Khim., 42: 682-5(Mar. 1968). (In Russian).

The partial molar and integral thermodynamic values for formation of Zn–U alloys from liquid components and of the compound U_2Zn_{17} from solid U and liquid Zn were calculated. The temperature dependence of the solubility of U in liquid Zn was determined, and it was expressed in the interval from 974 to 1125°K by the equation $\lg N_U = 6.1151 - 8370.3/T$. (tr-auth)

28787 INVESTIGATION BY THE ELECTROMOTIVE FORCE METHOD OF THE STATE OF LIQUID LANTHANUM–BISMUTH SOLUTIONS. Kober, V. I.; Lebedev, V. A.; Nichkov, I. F.; Raspopin, S. P. (Ural Polytechnic Inst., Sverdlovsk, USSR). Zh. Fiz. Khim., 42: 686-9(Mar. 1968). (In Russian).

The thermodynamics of liquid La–Bi solutions were investigated by the emf method. It was established that the activity coefficient of La in Bi in some approximations obeys Henry's law and changes with the temperature according to the equation $\lg \gamma_{La} = 0.844 - 11070/T \pm 0.073$. For the activity coefficient of La in Bi-saturated solution, the very precise expression $\lg \gamma_{La'} = 0.779 - 10959/T \pm 0.014$ was obtained. The variations of the excess partial molar values of La in the process of the formation of liquid solutions of La–Bi from liquid components at 900°K were found. Calculations were made of the integral values. The solubility of La in Bi varies with temperature according to the equation $\lg N = 2.518 - 3483/T \pm 0.035$. (tr-auth)

28788 INVESTIGATION BY THE ELECTROMOTIVE FORCE METHOD OF THE STATE OF URANIUM IN LIQUID URANIUM–BISMUTH SOLUTIONS. Lebedev, V. A.; Nichkov, I. F.; Raspopin, S. P. (Ural Polytechnic Inst., Sverdlovsk, USSR). Zh. Fiz. Khim., 42: 690-3(Mar. 1968). (In Russian).

The thermodynamic characteristics of the formation of liquid solutions of U with Bi were studied by the emf method. Assumptions were made on the existence in the solution of structure groupings, close to the composition in the compound U_3Bi_4. The solubility of U in Bi at 500 to 800°C was determined more precisely. (tr-auth)

28789 INVESTIGATION BY THE ELECTROMOTIVE FORCE METHOD OF THE THERMODYNAMICS OF THE INTERMETALLIC COMPOUNDS OF BISMUTH WITH URANIUM. Lebedev, V. A.; Nichkov, I. F.; Raspopin, S. P.; Kapitonov, V. I. (Ural Polytechnic Inst., Sverdlovsk, USSR). Zh. Fiz. Khim., 42: 694-7 (Mar. 1968). (In Russian).

Four regions with constant uranium activity were established in the U–Bi system. The existence of three intermetallic compounds (UBi_2, U_3Bi_4, and UBi) was confirmed. Variations of the partial molar values of U in Bi and of the integral values in the process of the formation of U–Bi compounds were found. An equation was proposed for the change in the free energy in the temperature interval studied. The maximum change $\Delta H = -12.26$ kcal/g-atom corresponds to the formation of the very stable compound U_3Bi_4, which is characterized by the greatest regularity. A comparison was made of the results with the data of other investigators. (tr-auth)

28790 THERMODYNAMIC PROPERTIES OF ALLOYS OF THE ZIRCONIUM–NIOBIUM SYSTEM. Fedorov, G. B.; Smirnov, E. A.; Makhlin, N. A.; Kalinin, P. I. (Moscow Engineering-Physics Inst.). Zh. Fiz. Khim., 42: 663-6(Mar. 1968). (In Russian).

By measurement of the vapor pressure of Zr, thermodynamic properties of alloys of the Zr–Nb system were investigated. The measurements were carried out by means of the Knudsen effusion method using the radioisotope ^{95}Zr in the temperature interval from 1250 to 1740°C. Pure Zr and its alloys with 10, 25, 50, and 90 at. % Nb were investigated. From the results obtained, the activity of Zr, the activity of Nb (using the Hibbs–Duhem equation), and the integral and excess thermodynamic functions of the system (free energy, entropy, and heat of mixing) were calculated. In almost the entire interval of temperature and concentration studied, a negative deviation of the activity and thermodynamic functions from the ideal were observed, and the maximum deviation corresponds with the concentration range from 15 to 20 at. % Nb, which is connected with the increase of the stability of the interatomic bonds in the solid solution. (tr-auth)

28791 THERMODYNAMIC PROPERTIES OF SOLID SOLUTIONS OF TUNGSTEN IN COBALT. Larikov, L. N.; Shmatko, O. A.; (Inst. of Metal Physics, Kiev). Zh. Fiz. Khim., 42: 793-5(Mar. 1968). (In Russian).

The thermodynamic functions of solid solutions of W in Co were calculated by the method proposed by Borelius. Solubility curves from the constitution diagram of the Co–W system, made more precise in the preliminary investigation, were used in the calculation. The thermodynamic properties of the solid solution of W in Co were used for calculation of the linear rate of increase of the eutectoid-like nucleus, originating in the decay process of supersaturated solid solution. By comparison of experimental values with theoretical curves, completely satisfactory agreement was obtained. (tr-auth)

28792 ADDITION OF COBALT TO THE Ti–6Al–4V ALLOY. Diderrich, E.; Rudinger, K.; Turlach, G.; Habraken, L. J. Metals, 20: 29-37(May 1968).

Test data showed that an addition of 3% cobalt to the Ti–6Al–4V alloy did not have an unfavorable influence on the workability of the alloy. Concerning hardenability, an increase in strength of about 25 kg/mm^2 (35.6 ksi) was obtained without affecting ductility. Thermal stability remained unaffected up to temperatures of about 400°C (752°F). Under dynamic stress, especially for high amplitudes, the cobalt-containing alloy exhibited a superiority to the Ti–6Al–4V alloy. These observations may lead to the conclusion that this alloy would be an interesting high-strength fastener material. (auth)

28793 BERYLLIUM SELF-DIFFUSION. Pavlinov, L. V.; Grigor'ev, G. V.; Sevast'yanov, Yu. G. Fiz. Metal. Metalloved., 25: 565-7(Mar. 1968). (In Russian).

Self-diffusion of polycrystalline 99.9% pure Be annealed for 2 hr at 1100°C was studied using radioactive ^7Be isotope produced in $^7Li(\alpha,2n)^7Be$ reaction. Curves were constructed of the specific activity as a function of the diffusion quadratic for temperatures of 650, 800, 900, 1000, and 1200°C. Experimental values of diffusion coefficients are tabulated. (R.V.J.)

28794 EFFECT OF NIOBIUM ON THE STRUCTURE AND PROPERTIES OF CHROMIUM–MANGANESE STEELS. Pirtskhalayshvili, V. A.; Nabichvrishvili, M. A. Soobsch. Akad. Nauk. Gruz. SSR, 45: 155-60(1967). (In Russian).

The effect of 0.15 to 4.5% Nb on the structure and properties of Cr–Mn steels containing 12 to 22% Cr, 15 to 18% Mn, 0.15 to 0.55 (N + C) and additionally alloyed with 0.5 to 2.0% Mo, 5% Ni, or 0.5% W has been investigated. The steels were annealed at 1200°C for 5 hr and water cooled (steel containing 15% Cr, 15% Mn, and 5% Ni was additionally aged at 700°C for 25 hr) and subjected to bend tests at 700 to 750°C under a stress of 15 kg/mm^2. Analysis of the tests showed that addition of 0.3 to 0.5% Nb sharply increases resistance to deformation of austenitic Cr–Mn steel at 550 to 850°C, but with increasing niobium over 1.5% and formation of ferrite structure through high concentration of nitrogen and carbon, the resistance to deformation significantly dropped. Alloying with up to 1.5% Nb and 0.5% Mo was most effective in increasing the resistance to deformation, but reduced the rate of aging process. Aging and an excess of nitride and carbonitride phases in steel also increased the resistance to deformation. (ATD)

28795 ELECTROCHEMICAL OXIDATION OF RHENIUM, MOLYBDENUM, TUNGSTEN, AND SOME RHENIUM ALLOYS. ANALYTICAL APPLICATIONS. Tribalat, S.; Piolet, C.; Mofidi, Dj. Bull. Soc. Chim. Fr., 2: 844-8(Feb. 1968). (In French).

Anodic oxidation curves E = f(i) for rhenium, molybdenum, tungsten, and binary rhenium alloys were plotted for various media. Oxidizability of rhenium is related to the quality of its crystalline structure. The following applications were suggested by an examination of the polarization curves: coulometric analysis at constant intensity of rhenium deposits on various supports (the dissolution potential depended on the treatment undergone by the metal); evidence for hydrogen occluded inside rhenium crystallized in the presence of this gas; dissolution and coulometric analysis of electro-oxidizable rhenium alloys, with the example of solid solutions of rhenium in molybdenum or tungsten (in the latter case, the dissolution potential was a linear function of the titre in rhenium); and study of homogeneity for one of these alloys. (auth)

28796 FLUID FLOW OF LIQUID PLUTONIUM ALLOYS IN AN OSCILLATING-CUP VISCOSIMETER. Wittenberg, L. J. (Monsanto Research Corp., Miamisburg, Ohio); Oftie, D.; Curtiss, C. F. Contract AT-33-1-GEN-53. J. Chem. Phys., 48: 3253-60(Apr. 1, 1968).

An oscillating-cup viscosimeter was utilized to measure the viscosity of three low-melting plutonium alloys. The derived relationship for the viscosity calculation was confirmed by measurements on standard viscosity oils and on liquid metals that covered wide ranges of viscosities. Abnormal behavior was detected for the plutonium alloys. When the period of oscillation was greater than 11.0 sec for the three plutonium alloys, the logarithmic decrement passed through a maximum, then decreased as the temperature decreased; at the same time the period of oscillation increased greatly. When the period of oscillation was 2.7 sec, the plutonium alloys behaved normally but showed very large viscosities, which approached 25 centipoises. The cause of the anomalous behavior was not determined but indicated possible viscoelastic or non-Newtonian behavior. (auth)

28797 MECHANICAL PROPERTIES OF HYDRO-EXTRUDED MOLYBDENUM FOLLOWING ANNEALING. Mochalov, G. A.; Martynov, E. D.; Beresnev, B. I.; Evstyukhin, A. I.; Rodionov, K. P.; Bulychev, D. K.; Ryabinin, Yu. N. (Moscow Inst. of Engineering Physics. Inst. of Physics of Metals, Moscow). Fiz. Metal. Metalloved., 25: 529-37(Mar. 1968). (In Russian).

Mechanical properties of hydro-extruded and non-extruded molybdenum of various content were studied following 1-hour annealing at 800 to 2000°C. After recrystallization annealing, extruded non-alloyed ceramic molybdenum exhibited an increased hardness and the highest plasticity due to the formation of fine grain recrystallization and formation of recrystallization texture (101). In contrast to the pure hydro-extruded Mo, the industrial lightly alloyed molybdenum became embrittled after recrystallization annealing due to the disintegration of the saturated solid solution of impurities in molybdenum. (R.V.J.)

28798 ON THE AGING CHARACTERISTICS OF COPPER-2wt PERCENT BERYLLIUM ALLOYS WITH OR WITHOUT ADDITIONAL ELEMENTS. Murakami, Yotaro; Yoshida, Hiroyuki; Yamamoto, Satoru (Kyoto Univ.). Trans. Jap. Inst. Metals, 9: 11-18(Jan. 1968).

An investigation of the effects of quenching and aging temperatures and of additional elements on the aging characteristics of copper-2 wt.% beryllium alloys has been carried out mainly by means of electrical resistance measurements. It has been found that appreciable clustering of solute atoms occurs during quenching and the rate of pre-precipitation during isothermal aging increases greatly with increasing quenching or aging temperature. It has also been observed that the increase in resistivity decreases with increasing aging temperature. The activation energy for the zone formation in the high purity binary alloy after quenching from 800°C is estimated to be 1.1 eV. The effect of additional elements on the zone formation process can be summarized. Magnesium and zinc accelerate zone formation, whereas cobalt and iron retard it. The role of vacancy appears to be a fundamental one in determining the rate of zone formation. The variations of the maximum increase in resistivity against the various aging temperatures have been explained in terms of the variations of the number of zones formed. Reversion and effects of additional elements are also discussed. (auth)

28799 NON-ELASTIC STRESSES IN COMPOSITE PLATES UNDER TRANSIENT THERMAL CONDITIONS. Lewis, D. J.; Campbell, J. S. (Central Electricity Generating Board, Berkley, Eng.). J. Strain Anal., 3: 103-8(Apr. 1968).

A direct solution was developed for finding the stresses induced by thermal transients, in composite plates, for equal biaxial stresses. A computer program was written and specimen results are shown. Non-elastic effects are included and residual stresses can be found. The program can be used in any situation where a shell component has material properties varying through the shell thickness, provided that the stress system is equi-biaxial. (auth) (UK)

28800 THE EFFECT OF TUNGSTEN ADDITIONS ON PROPERTIES OF NEW MAGNET ALLOY "MALCOLLOY" IN THE SYSTEM OF COBALT AND ALUMINIUM. Masumoto, Hakaru; Kobayashi, Takeo; Watanabe, Kiyoshi (Research Inst. of Electric and Magnetic Alloys, Sendai). Trans. Jap. Inst. Metals, 9: 1-5 (Jan. 1968).

Since the new magnet alloy "Malcolloy" of high coercivity in the system of cobalt and aluminium was developed, the effects of additions of nickel, molybdenum, titanium, vanadium and chromium on its magnetic properties were studied. The highest coercive found was 1600 Oe. The addition of tungsten was found to increase the coercive force of the binary alloys. The alloy which exhibits the highest coercivity has the composition of 75.89% Co, 13.55% Al and 10.56% W and shows the coercive force of 1450 Oe, the residual magnetic flux density of 3100G and the maximum energy product of 1.40×10^6 G · Oe when tempered at 525°C for 150 hours after water quenching from 1380°C. These alloys consist of many ferromagnetic elongated particles about 350 Å in diameter which are dispersed in the matrix of nearly nonmagnetic β' phase. Consequently, it may be concluded that the high coercivity of these alloys is mainly caused by the presence of the fine particles of a single magnetic domain. (auth)

28801 OBSERVATION OF CAVITIES IN URANIUM BY ELECTRON MICROGRAPHY AT VERY HIGH PRESSURE. Giraud-Heraud, Francois; Guillaumin, Jean (CNRS, Toulouse. Laboratoires de la Societe Industrielle de Combustible Nucleaire, Isere, France). Compt. Rend., Ser. C, 266: 963-4(Mar. 25, 1968). (In French).

Test bars of uranium were deformed by creep under traction at 400°C. By examination in an electron microscope, at a voltage of 1000 kV, of thin sheets of a thickness in the neighborhood of 2μm taken from these bars, evidence was shown for intergranular cavities formed in the course of creep. (tr-auth)

28802 ANALYSIS OF PRESSURE-TEMPERTURE INFLUENCE IN TUNGSTEN CONSOLIDATION. Zima, Gordon E.; Lakner, John F. (Univ. of California, Livermore). Int. J. Powder Met., 4: 19-32(Apr. 1968).

The production of ingots of sound macrostructure has enabled a quantitative densification analysis of submicron tungsten using both belt and piston-cylinder high-pressure apparatus. Pressure, temperature, and time ranges were 0.4 to 35 kbar, 600 to 1400°C, 10 sec to 20 min, respectively. Under 23 kbar, 1170°C, and 10 min, sound ingots within 0.4% of theoretical density were obtained. A pressure survey at 1080°C and 10 min revealed a virtual densification equivalence of pressures ranging from 30 to approximately 1.0 kbar, with a sharp break in pressure influence occurring near 1 kbar. A density maximum near 1100°C has been correlated with the onset of grain growth under pressure. Over a mean particle size range of 0.25 to 7.0 μ, ingot gas content appears to be the primary determinant of end-point density. Close agreement was obtained with theoretical end-point density predictions based on the plastic flow densification mechanism. Self-diffusion and activation-energy data calculated from 23-kbar processing agreed closely with data obtained from pressureless sintering. (auth)

28803 THE WORK FUNCTION BEHAVIOR OF A WATER VAPOR CONTAMINATED Re–Nb ALLOY SURFACE. Sahm, P. R. (RCA Labs., Princeton, N. J.). Surface Sci., 9: 133-6 (Jan. 1968).

Equipment and procedures for qualitative studies of water vapor absorption on electron emitter surfaces at elevated temperatures are described. A Re-base-Nb alloy was used as an emitter. (P.G.C.)

28804 DESORPTION, MOBILITY AND WORK FUNCTION CHANGE OF MERCURY ON TUNGSTEN AND MOLYBDENUM SUBSTRATES. Swanson, L. W.; Strayer, R. W.; Davis, L. E. (Field Emission Corp., McMinnville, Oreg.). Surface Sci., 9: 165-86(Feb. 1968).

Surface diffusion, thermal and field desorption studies for the Hg/W and Hg/Mo systems are described. Terminal coverage thermal desorption energies are 1.82 ± 0.15 and 1.92 ± 0.18 eV for the Hg/Mo and Hg/W systems respectively. Surface diffusion activation energies (E_d) for Hg are 0.51, 0.40, and 1.0 eV for the (111), (123), and (100) planes respectively of W. An unusually large ratio of E_d/E_a, where E_a is terminal coverage value, for the Hg/W system is discussed in light of the surface bond type involved, and the variation of E_d with crystal plane is described reasonably well by a Lennard-Jones 6–12 interaction potential. Increasing coverage of Hg causes the work function of both substrates to first increase 0.40 eV and then decrease. (auth)

28805 THE CREEP RUPTURE PROPERTIES OF PRESSURE VESSEL STEELS. PART III. Steiner, C. J. P.; de Barbadillo, J. J.; Pense, A. W.; Stout, R. D. Weld. J. (N. Y.), 47: 144s-54s (Apr. 1968).

The investigation included 10 steels, many of which are covered by recent ASTM designations, such as A517, A533, A542, and A543. The steels were tested in the 800 to 1100°F range for rupture lives up to 10,000 hr. Fabrication discontinuities, such as mechanical and metallurgical notches, were incorporated into this study. In order to determine the effects of metallurgical notches on creep rupture strength, the standard 0.252 in. dia creep specimen was adapted to include weld metal and weld heat-affected zone structures, as well as base metal material, in the test section. Mechanical notches were superimposed on both

welded and unaffected base metal to determine the influence of these combined effects on rupture properties. In the temperature range included for study there were two regions of interest. The lower region, at 800 to 1000°F, was primarily related to service behavior, and the longer time data were of specific interest. The higher region, at 1000 to 1200°F, was of interest in relation to thermal treatment during fabrication where the shorter time data are most applicable. To evaluate data obtained from the higher temperature portion of the program, welded restraint tests given thermal treatments in the 800 to 1200°F were included in the investigation. To complement the testing portion of the creep-rupture program, light and electron metallography was performed on the materials studied so that the nature of fracture could be determined under the varying conditions of stress, temperature and thermal treatment. The results of this investigation show that the materials studied may be divided into groups on the basis of rupture strength and ductility at 1000°F. The carbon steel had generally low rupture strength but good rupture ductility in this temperature range. The manganese-molybdenum and nickel-chromium-molybdenum steels had intermediate strengths but generally low rupture ductilities, while the chromium-molybdenum (-vanadium) steels with less than 1% chromium had intermediate rupture strengths but much higher rupture ductilities. The chromium-molybdenum steels with over 1% chromium had the highest rupture strengths at 1000°F and good rupture ductilities over the range of times tested in the program. In the probable service temperature range of these steels, the quenched and tempered steels retain a useful advantage in creep-ruptured strength over the normalized grades. This range increases as the chromium and molybdenum content of the steel increases. At higher temperatures, the normalized microstructures are superior. Welding generally reduced the rupture ductility of the steels, many showing preferential intergranular cracking in the weld heat-affected zone. For some materials, rupture stresses were decreased somewhat due to welding. Changing welding heat input only modestly altered this pattern. Mechanical notches had both notch strengthening and notch weakening effects, depending on the specific material studied. Welded and notched specimens responded to notching in the same manner as the notched unwelded ones. Thermal treatments given to weld restraint specimens produced cracks during short time high temperature tests. These cracks appear to result from low rupture ductility in the weld heat-affected zone. (auth)

28806 MASS SPECTROMETRIC ANALYSIS OF LOW TEMPERATURE FIELD EVAPORATION. **Barofsky, Douglas F.; Mueller, Erwin W. (Pennsylvania State Univ., University Park). Surface Sci., 10: 177-96(May 1968).**

At liquid hydrogen temperature, field evaporation of Be, Fe, Cu, and Zn in a back-ground vacuum of approximately 10^{-7} torr yields Be^{2+}, Fe^{2+}, Cu^{+}, Cu^{2+}, Zn^{+}, and Zn^{2+} respectively. At liquid nitrogen temperature nickel field evaporates as Ni^{2+}. The charges of the detected ions of these metals are essentially those predicted from the image force theory of field evaporation. Beryllium exhibits a change in its evaporated ion species from Be^{2+} to Be^{+} as the temperature is raised from 21 to about 300°K. This result is wholly unexpected and requires extension of the present theory. The behavior of iron, nickel, copper, and zinc as a function of temperature is complicated by the appearance of molecular oxygen at about 150°K and the subsequent formation of ionic oxides of these metals. In the presence of hydrogen nearly all of the metals exhibited hydride ions, and their identification was confirmed by producing the corresponding deuteride ions. Beryllium produces BeH^{+} predominantly; some traces of BeH^{2+} are evident at 21°K. The field reaction product of hydrogen and copper is CuH_2^{+}. FeH_2^{2+} and NiH^{2+} are apparently the predominant ion species of iron and nickel respectively. No hydrides of zinc could be detected unambiguously. (auth)

28807 PLASTIC PROPERTIES OF MONOCRYSTALS OF THE ALLOY MAGNESIUM-5 ATOMIC PERCENT INDIUM. **Bach, Pierre; Escaravage, Claude; Champier, Georges (Centre National de la Recherche Scientifique, Nancy, France). Compt. Rend., Ser. C, 266: 1029-31(Apr. 1, 1968). (In French).**

The plastic properties of the alloy magnesium-5 atomic % indium were studied by tensile stress of the monocrystals at room temperatures varying from 77 to 290°K. It was shown that the influence of indium on the value of the critical shear for slippage along the (0001) plane varied inversely with the temperature and must be attributed to effects other than shear. (tr-auth)

28808 INFLAMMABILITY OF ZIRCONIUM POWDERS AND ITS ALLOYS IN SUSPENSION. **Ioffe, V. G. Porosh. Met., Akad. Nauk Ukr. SSR, No. 3, 100-4(Mar. 1968). (In Russian).**

The values of the lower concentration limit (LCL) of explosive mixtures were determined by experiments for powders Zr, Ti, Si immediately after the preparation and 4 months after keeping in the open air. The values of LCL for powders of binary alloys Zr-Ti and Zr-Si are determined over the whole range of concentration. The dependence of LCL on the alloy composition is close to the dependence of pyrophoricity temperature on the composition and is connected with the diagram of alloy state. The inflammability of the powder is determined by its chemical activity; the thermal effect is of secondary importance. The microscopic investigation of the combustion products shows that the combustion of the investigated powders takes place at the surface of the fused particles except silicon which, is probably, burned down in the steam phase. (auth)

28809 HEAT EXPANSION OF MOLYBDENUM-COPPER AND TUNGSTEN-COPPER PSEUDOALLOYS. **Rabkin, V. B.; Kozlova, R. F. Porosh. Met., Akad. Nauk Ukr. SSR, No. 3, 64-70(Mar. 1968). (In Russian).**

A concentration dependence of heat expansion is investigated in W-Cu and Mo-Cu pseudoalloys obtained by liquid-phase sintering. The peculiarities of the heat expansion of two-phase alloys are considered. These peculiarities are connected with the texture, plastic hysteresis, and porosity. On the basis of W-Cu and Mo-Cu systems it is possible to create a series of alloys with the preset expansion for unstressed solders with dielectrics. (auth)

28810 INCREMENTAL GROWTH DUE TO CREEP AND PLASTIC YIELDING OF THIN TUBES SUBJECTED TO INTERNAL PRESSURE AND CYCLIC THERMAL STRESSES. **Bree, J. (Heriot-Watt Univ., Edinburgh). J. Strain Anal., 3: 122-7(Apr. 1968).**

A theoretical investigation is made of incremental growth in a thin pressurized tube when the tube wall is subjected to large cyclic variations of temperature and temperature gradient, the mechanisms of deformation being plastic yielding during application and removal of the temperature gradient, and creep during the high temperature part of the cycle. Earlier work (NSA 22: 3859) is applied to cases where only partial relaxation of internal stresses occurs, and a method of evaluating the ratchet strain per cycle is presented. In addition, the method allows the increased creep strain due to non-linear interaction between internal stresses and the pressure stress to be calculated. This increased creep strain accompanies ratcheting when the relation between creep rate and stress is non-linear. (auth) (UK)

28811 DEFORMATION OF TANTALUM ALLOY SINGLE CRYSTALS. **Raffo, Peter Louis. Cleveland, Case Inst. of Tech., 1967. 205p.**

Thesis.

A study was made of the deformation of Ta-Re, Ta-W and Ta-Mo alloy single crystals at 77 to 623°K. Primary emphasis was on the alloys in the Ta-Re system. Slip was found to occur on {110} planes at 77 and 298°K. Three-stage work hardening was not observed in the alloys and the rate of work hardening at low strains was characteristic of stage II in the pure metal. Work softening was noted at high strains in the more concentrated alloys. The yield stress increased continuously with alloying, above room temperature, while at low temperatures, it first decreased with alloying and passed through a minimum before increasing again with composition at higher concentrations. The rate of alloy hardening was considered for several bcc alloy systems at 298°K and it was found that the predominant interaction was with the strains around misfitting solute atoms. The decrease in yield stress at low temperature was attributed to a decrease in the Peierls stress. The increase in yield stress was due to the overcoming of the stress fields of individual solute atoms. Cleavage occurred in tension at high compositions and low temperatures in Ta-Re alloys. This was attributed to a decrease in the rate of dislocation multiplication through a decrease in the ease of cross slip. Confirmation for this was found in the presence of screw dipoles in transmission electron micrographs in Ta-10.6% Re deformed at 298°K. (Diss. Abstr.)

28812 SPECIFIC HEAT AND HALL EFFECT MEASUREMENTS OF CHROMIUM-VANADIUM AND CHROMIUM-MOLYBDENUM ALLOYS. **Shabel, Barrie Steven. Syracuse, N. Y., Syracuse Univ., 1967. 82p.**

Thesis.

Specific heat and Hall Effect measurements were carried out on various Cr-V and Cr-Mo alloys. The specific heat, measured at constant pressure in an adiabatic calorimeter at 125 to 625°K, could be separated into lattice, dilatational and electronic contributions. The electronic term could be written as $C_E = \gamma^* T$ with γ^* an effective electronic specific heat coefficient. Values of γ^* ranged from $12\text{-}16 \times 10^{-4}$ cal/mole-deg^2 for the Cr-V alloys and from $5\text{-}12 \times 10^{-4}$ cal/mole-deg^2 for the Cr-Mo alloys. For Cr-rich V

alloys, γ^* was greater than γ_0, the electronic specific heat coefficient measured in the liquid helium temperature range. With increasing V content, γ^* approached γ_0. These results were consistent with the behavior expected from previous theoretical considerations of the effects of the curvature of the density of states versus energy curve on the electronic specific heat. Although no low-temperature specific heat data were available for comparison for the Cr-Mo alloys, the behavior of γ^* could be interpreted by attributing the reduced γ^* with increasing Mo content to a reduction in curvature of the density of states curve as the band structure changed from a 3d to 4d character. The Hall Effect measurements showed that Cr, the Cr-V alloys, the Cr-Mo alloys and Mo all had positive Hall coefficients, indicative of predominant hole conduction. Pure Cr yielded field-dependent Hall coefficients at 4.2 and 77°K, which could be fitted using the standard two-band model, in fields up to 147 kiloG. The room temperature value was approximately 37×10^{-13} volt-cm/amp-Gauss and was field-independent. None of the Cr-V alloys showed any field-dependent effects in fields up to 100 kiloG at 77 and 298°K. Dilute Cr-V alloys, however, revealed markedly increased Hall coefficients at 77°K compared to that observed at 298°K. A maximum effect was observed in a Cr-1% alloy. This was attributed to the effect of antiferromagnetic ordering below the Neel temperature, T_N, for alloys where 77°K T_N 298°K. The Hall coefficients in the higher V content alloys could be qualitatively interpreted in terms of the possible variations in the Fermi surface area. The Cr-Mo alloys, however, yielded Hall coefficient results that were quite similar to those found in Ag-Au alloys. There was little variation with composition and temperature in the range from 25-75% Mo measured at room and liquid nitrogen temperatures. The Hall coefficients ranged from $9\text{-}13 \times 10^{-13}$ Volt-cm amp-gauss. These results were attributed to the influence of anisotropic, impurity-dominated scattering on the Hall coefficient. (Diss. Abstr.)

28813 INTERACTION ENERGIES IN NON-STOICHIOMETRIC $Zr_xNb_{1-x}C_y$. Jun, Choll Kyu. Cincinnati, Univ. of Cincinnati, 1967. 44p.

Thesis.

The non-stoichiometry of Zr-Nb-carbide with the NaCl type structure, $Zr_xNb_{1-x}C_y$, was studied by measuring the activities of the components as a function of composition. Equations for the activities of the components as a function of composition were derived from statistical considerations, based on the pairwise interaction energies between various components. The energies were determined by measuring the variations with composition of the ratio of the activities of the various components. The ratio of activities of the various components at one composition was determined in one experiment; thus the usual errors in temperature measurement were eliminated. The samples were prepared by heating the required amounts of oxides and graphite in a high-vacuum induction furnace. Lattice parameters were measured on all specimens. At constant C concentration (y = constant), the lattice parameter deviates somewhat from Vegard's law at the Nb rich end. The metal-metal interaction energy, $[E_{12} - (E_{11}/2 + E_{22}/2)] = 6.54 \pm 0.27$ kcal/mole, is not much different from that in the bcc metallic Zr-Nb system. The difference between the Zr-C and Nb-C interaction energies $(E_{13} - E_{23}) = -5.16 \pm 1.59$ kcal/mole, whereas E_{33}, the C-C interaction energy, can be expressed as $E_{33} = 15.62 + 9.37x - 29.50x(1-x)$ kcal/mole. (Diss. Abstr.)

28814 STRUKTURA I SVOISTVA ZHAROPROCHNYKH METALLICHESKIKH MATERIALOV. (Structure and Properties of Heat-Resistant Metallic Materials). Pridantsev, M. V. (ed.). Moscow, Izdatel'stvo Nauka, 1967. 351p.

New theoretical and experimental data on heat-resistant metals and metallic alloys are reviewed. The role of dissolved atoms in the diffusion and strengthening of metals, and the ductile to brittle state of high-melting metals are discussed. Thermal stability of defects in crystalline lattice, creep, and cracking processes are analyzed. Physico-chemical properties, structure, and thermomechanical effects on structural dislocations, corrosion, and protective coatings are also covered. (R.V.J.)

28815 EXCHANGE OF ENERGY BETWEEN TUNGSTEN AT HIGH TEMPERATURES AND GASES AT ROOM TEMPERATURE. Lim, Mahn-Jick. Berkeley, Calif., Univ. of California, 1967. 100p.

Thesis.

The exchanges of energy between a W filament and room temperature Ne, N, Ar, Kr, O, N_2O, and NO_2, mixtures with Ne with Kr, and mixtures of Ar with O were studied over a wide range of filament temperatures and gas pressures. For non-reactive gases, the thermal accommodation coefficient was found to be independent of gas pressures between 1×10^{-7} atm and 5×10^{-5} atm and to depend on filament temperatures in a complex manner in the temperature range from 700 to 2800°K. The general trends in temperature dependences of the thermal accommodation coefficients are similar for the noble gases and for N. The variations for these gases are believed to reflect, primarily changes in the fraction of coverage of adsorbed surface impurities and in surface structures. All show maximum thermal accommodation coefficients near 2000°K. For O, below 1500°K, the energy exchange phenomenon is very similar to those for non-reactive gases. At 1500 to 1800°K an exothermic energy exchange occurs that is nearly independent of gas pressure. Above 1900°K, where the exchange is again endothermic, the pressure dependence of the energy exchange becomes more pronounced as the solid temperature is further raised. At very low O pressures, an abnormally high apparent energy exchange was observed presumably due to instantaneous C content change causing an electrical resistance change and due to large errors in the measurement of energy exchange at low pressures. For O, NO, and N_2O, the energy exchange at about 2600°K is high enough to support the conclusion that essentially all incident molecules react. The energy exchanges of mixtures of Ne with Kr are essentially the arithmetic sums of the energy exchanges of the individual species at 2142°K. The same was found for Ar-O mixtures at 2528°K. At 1740 and 2200°K, departure from this simple addition rule was found especially for higher O mole fractions. (Diss. Abstr.)

28816 DISSOCIATION OF HYDROGEN ON TANTALUM USING MODULATED MOLECULAR BEAM TECHNIQUE. Krakowski, Robert Anthony. Berkeley, Calif., Univ. of California, 1967. 273p.

Thesis.

The dissociation of molecular hydrogen on hot tantalum surfaces has been investigated with a high vacuum apparatus using a modulated molecular beam-mass spectrometric technique. A modulated beam of molecular hydrogen, formed by effusion from a high pressure source, impinged upon the tantalum target. The reflected H_2 and H atoms emitted after surface dissociation were monitored by a mass spectrometer in the vacuum system. The beams were modulated and the products measured by a phase-sensitive detector to improve the signal-to-noise characteristics of the detection system. The degree of dissociation was studied as a function of the surface temperature, beam temperature, and beam intensity. Experimental results have been analysed in terms of phenomenological first and second order kinetic models. Within the pressure (3×10^{-7} torr) and temperature (1000 to 2500°K) ranges studied, all data agreed best with the first order mechanism, and yielded 65 kcal/mole for the hydrogen/metal bond energy. At a given temperature, dissociation increased with the beam temperature with an apparent activation energy of 1.4 kcal/mole, which was independent of the surface temperature. The rate of dissociation varied linearly with the beam intensity. Mixed hydrogen/deuterium beams were employed to investigate the isotope exchange reaction, and, within the sensitivity of the detection system, exchange did not take place. A simple kinetic model, which proposes a high adatom recombination probability before significant surface diffusion occurs, was proposed to explain the observed first order kinetics. Also, hydrogen solubility in the metal bulk has been considered as a possible source for the observed non-equilibrium behavior. (Disser. Abstr.)

28817 FIELD ION MICROSCOPE INVESTIGATION OF THE DIFFUSION OF CARBON IN TUNGSTEN. French, Robert Dexter. Providence, Brown Univ., 1967. 96p.

Thesis.

Volume diffusion of carbon in tungsten was studied with the ultra-high resolving power of the field-ion microscope. Carbon atoms in octahedral interstitial positions cannot be distinguished individually in the ion micrographs primarily because of their physical size relative to the size of a tungsten atom. At the limit of solubility of carbon in tungsten the carbon atoms have little, if any, disturbing effect on a clean tungsten image. The carbide W_2C appears mottled in the ion micrographs. Any planes which can be identified as such in the mottled area bear a near relation to a low index plane of the tungsten lattice. The carbide WC, identified by correlating the ion image with a $(2\bar{1}\bar{1}2)$ stereographic projection of WC, is related to the tungsten lattice in a similar fashion. Both observations are consistent with the expected mode of formation of the respective carbide structure from bcc tungsten. Advance of the W_2C phase boundary along (011) – {112} zone lines appears to be associated with dislocations in the same region. The wedge-shaped appearance of the W_2C phase cutting through {112} planes suggests a boundary made up of perfect edge dislocations having a strength $\bar{b} = a\sqrt{3}/2$. (Disser. Abstr.)

Structure and Phase Studies

Refer also to abstract 27738.

28818 (BARC-303) DIFFUSION BONDING IN VANADIUM AND ZIRCONIUM. Vermani, S. K.; Murarka, S. P.; Agarwala, R. P. (Bhabha Atomic Research Centre, Bombay (India)). 1967. 10p. Dep.

Couples of high purity V and Zr were heated for 10 hrs at 400 and 950°C. Those formed at 950°C were firmly bonded but without interdiffusion. The couples were then annealed in He at 400 to 1050°C and the diffusion bands were measured. Phase diagrams for the V-Zr diffusion systems are shown as are equations for diffusion parameters. It was concluded that V is a suitable barrier for protection of Zr from hydriding in organic reactors. (P.G.C.)

28819 ON THE STRUCTURE OF THE COMPOUNDS $Ag_3R.E.$ (R.E. = Y, La, Ce, Sm, Gd, Dy, Ho, Er). Steeb, S.; Godel, D.; Loehr, C. (Max-Planck-Institut fuer Metallforschung, Stuttgart). J. Less-Common Metals, 15: 137-41(June 1968).

The intermetallic compounds $Ag_3R.E.$ with R.E. = Y, La, Ce, Sm, Gd, Dy, Ho, and Er are isotypical with Ag_3Pu, the hexagonal elementary cell containing 64 atoms. A figure is given, which shows the smooth variation of the mean atomic volume vs. the concentration in at.% in the eight systems Ag-R.E. concerned. The results of high-temperature investigations of the phase Ag_3Sm are given. Thermal expansion coefficients are: $\Delta a/\Delta T = 1.5 \times 10^{-4}$ kX/°C and $\Delta c/\Delta T = 1.7 \times 10^{-4}$ kX/°C. (auth)

28820 STRUCTURE AND CORRELATION IN LIQUID ALLOYS BY X-RAY AND NEUTRON DIFFRACTION. Henninger, E. H. (Purdue Univ., Lafayette, Ind.); Buschert, R. C.; Heaton, LeRoy Advan. Phys., 16: 177-88(Apr. 1967).

A method for obtaining information about correlation in a liquid or amorphous alloy is presented. The explicit structure in a binary could in principle be determined from three independent diffraction patterns. It is relatively much simpler to measure and analyse the x-ray and neutron intensity patterns and with these alone obtain considerable correlation information, even if more than two atom types are present, by calculating the ratio of the two experimental radial distributions. For the binary the relevance of the ratio derives from the fact that each distribution is a sum of the radial distributions of the three types of atom-pairs, each term being weighted by the appropriate product of scattering amplitudes. The structure of the sample can be analysed by comparing the ratio for any interatomic distance to the values it would have for pure A-A, pure B-B, pure A-B, and random pairing. In a true liquid the results are semiquantitative. In an alloy with well-defined short-range order, the correlation of these close pairings can be clearly determined. Results are shown for liquid NaK and vitreous silica. For any alloy the experimental results would serve to test structural models. (auth) (UK)

28821 TERNARY FeB- AND CrB-TYPE PHASES WITH YTTRIUM, LANTHANUM, AND SOME RARE EARTHS. Raman, A. (Louisiana State Univ., Baton Rouge). Inorg. Chem., 7: 973-6(May 1968).

Rare earth equiatomic phases with similar CrB- or FeB-type structures form complete solid solutions with each other if the non-rare earth component is the same. GdNi and ErSi do not form continuous series of solid solutions, although their structures are similar. The structures of six new ternary phases were determined. The variations in the characteristics of the trigonal prisms in the CrB-type phases are analyzed. (auth)

28822 PRECIPITATION IN THE Fe-Mo SYSTEM. Marcus, Harris Leon. Evanston, Ill., Northwestern Univ., 1967. 204p. Thesis.

Changes in the Moessbauer spectrum and Young's Modulus during aging of a solid solution of an Fe-6 at. % Mo alloy were studied. A detailed study of the precipitation reaction in the Fe-6 at. % Mo alloy was made at 550 and 650°C. Moessbauer parameters were determined for Fe_2Mo, Fe_3Mo_2, and alloys of 2.5 and 20 at. % Mo. Changes in the Moessbauer spectra during aging of Fe-16 at. % Ni-3.5 at. % Mo, 17.7 PH stainless steel and an 18 Ni-8 Co-5 Mo maraging steel were studied. Moessbauer spectra of Kovar, 301, 303, 310 and 316 stainless steel were analyzed. The changes in the Moessbauer spectrum from the addition of Mo and Fe were analyzed on the basis of a 14 near-neighbor model. The six peaks of the Fe spectrum when Mo was added were changed into six envelopes of fine structure peaks and these envelopes were analyzed as a superposition of three peaks associated with 0, 1, and 2 Mo atoms among the 14 near-neighbors. The hyperfine field is -334 ± 1 K Oe, -295 1 K Oe and $\pm -255 \pm 2$ K Oe and the isomer shift is $+0.01 \pm 0.005$, -0.02 ± 0.01 and -0.05 ± 0.02 mm/sec for the 0-Mo peaks, 1-Mo peaks and 2-Mo peaks, respectively, for the as-quenched Fe-6 Mo alloy. The precipitation reaction during aging of the Fe-6 Mo alloy at 650°C was one step precipitation of stable Fe_2Mo. The 550°C aging sequence revealed a two stage reaction. First, clustering of Mo and finally, precipitation of stable Fe_2Mo. A rate exponent of 1.2 was determined from modulus and Moessbauer data and agrees with growth of rod-shaped platelets. The solvus composition, C_s, in the temperature range 650 to 870°C was found by analysis of Moessbauer spectra to satisfy the relation $C_s = \exp(-7400/RT)$ at. % Mo. This investigation also demonstrates the value of using Moessbauer spectroscopy to study the structures of steels. There are three main results. First, a quantitative measurement of retained and reverted austenite when it is paramagnetic can be made unaffected by texture. Second, a paramagnetic Fe-bearing precipitate such as the Fe_2Mo which was found to form during the latter stages of aging of maraging steels can be identified during a precipitation process. Third, by careful analysis of the changes in the magnetic internal field it is possible to determine which alloying elements are entering into the precipitation reactions such as depletion of Mo from the solid solution during the early stages of precipitation in maraging steels. (Disser. Abstr.)

28823 ANODIC OXIDATION OF Nb-Sn ALLOYS. Hoffmann, Marga; Maier, Richard G. (Forschungslaboratorium, Erlangen, Ger.). Prakt. Metallog., 3: 381-6(Dec. 1966). (In German).

The metallographic examination of samples of Nb-Sn alloys is usually carried out with the aid of the anodic oxidation method. A new simple electrolyte with better durability than others, which gives good results on Nb-Sn alloys is used. A phase analysis of different samples shows the usefulness of the method. (auth)

28824 FIELD-EMISSION STUDIES OF SURFACE MIGRATION FOR TUNGSTEN, RHENIUM, IRIDIUM, AND RHODIUM. Bettler, Philip C.; Barnes, George (Univ. of Nevada, Reno). Surface Sci., 10: 165-76(May 1968).

The activation energy and the diffusivity constant for surface migration, and the surface tension of the solid phase have been measured for several of the refractory metals by the pulsed field-emission techniques. The results of this work bring into question the reliability of the stopping-potential method for the measurement of the solid state surface tension. (auth)

28825 DISLOCATION ETCHING OF FORMED MOLYBDENUM. Pink, Erwin (Metallwerk Plansee AG., Reutte/Tirol, Austria). Jena Rev., No. 5, 305-7(1967).

The substructures were developed electrochemically with the aid of the Elypovist model and then viewed under an optical microscope at 2000x magnification. Deformation substructures were found to contain reticular structures, and identification of the lines is discussed. Dislocation densities were measured by counting the points. The effects of polygonization and grain boundaries are described. It is concluded that on surfaces accessible to dislocation etching and with no excessive deformation, the method supplies pictures of dislocation structures over large areas. (D.L.C.)

28826 CHEMISORPTION OF NITROUS OXIDE BY TUNGSTEN. Gasser, R. P. H.; Lawrence, C. P. (Physical Chemistry Lab., Oxford). Surface Sci., 10: 91-101(Apr. 1968).

A clean tungsten filament at room temperature adsorbs both the nitrogen and oxygen atoms of nitrous oxide with a sticking probability of ca 0.6. When the nitrogen atom uptake reaches 1.8×10^{14} atoms/cm^2 the filament is saturated with nitrogen but will still adsorb the oxygen atom. The nitrogen liberated by the adsorption of oxygen appears in the gas phase. The total uptake is $8.3 \pm 0.8 \times 10^{14}$ atoms/cm^2 and is independent of filament temperature between 296 and 1160°K. The ratio of nitrogen to oxygen atoms decreases with increasing filament temperature. Above ca 1400°K continuous decomposition of nitrous oxide occurs at a rate which increases with filament temperature to 1800°K and thereafter is constant. (auth)

28827 FIELD EMISSION WORK FUNCTION OF URANIUM ON TUNGSTEN. Collins, R. A.; Blott, B. H. (Univ. of Southampton, Eng.). Surface Sci., 9: 1-17(Jan. 1968).

Field emission microscopy was used to study the adsorption of monolayer and submonolayer films of uranium on tungsten. Three distinct adsorption states were observed in the temperature ranges corresponding to the bulk metal α, β, and γ phases. The final work functions were found to be 3.60 ± 0.03 eV at 295°K, 3.53 ± 0.03 eV in the range 934 to 1042°K and 3.43 ± 0.03 eV above 1042°K. Heat treatment of various initial deposits indicated a drop in work function at 934°K and at 1042°K, these changes being irreversible under all conditions. (auth)

28828 A FIELD EMISSION STUDY OF OXYGEN ADSORPTION ON THE (110), (211), (111), AND (100) PLANES OF TUNGSTEN. Bell, A. E.; Swanson, L. W.; Crouser, L. C. (Field Emission Corp., McMinnville, Oreg.). Surface Sci., 10: 254-74 (1968).

Oxygen was adsorbed at 78°K on the (110), (211), (100), and (111) planes of tungsten to give the following work function changes: $\Delta\phi_{110}$ = 1.0 eV, $\Delta\phi_{211}$ = 1.3 eV, $\Delta\phi_{100}$ = 1.5 eV and $\Delta\phi_{111}$ = 1.8 eV. On heating to 800°K the (110) and (211) planes developed considerably higher work function changes of 1.8 and 2.3 eV respectively which, together with the behavior of the Fowler–Nordheim preexponential, was taken to be indicative of desorption of oxygen from an electropositive state. At 1400 to 1800°K, the (110), (100), and (111) planes developed interesting peaks in the curves of preexponential versus temperature, which for the (100) and (111) planes were explained in terms of faceting. (auth)

28829 SEARCH FOR SUBSTRATE REARRANGEMENT IN BARIUM ADSORPTION ON TUNGSTEN. Frank, C. W.; Schmidt, L. D. (Univ. of Minnesota, Minneapolis). Surface Sci., 10: 275-86(May 1968).

Field ion microscopy was used to determine the extent of tungsten rearrangement upon barium adsorption and thermal equilibration. Measurements were carried out on both thermally annealed and field evaporated surfaces. It was shown that no tungsten rearrangement occurs upon barium impingement on field evaporated surfaces and that heating the barium covered surface to 652°K produces no rearrangement except on the (100) and (310) planes. On the latter changes were first observed at 627°K, and at 652°K these planes became completely disordered. On thermally annealed tungsten the (110) and (211) planes showed no visible changes upon heating to ~1000°K in the presence of barium. (auth)

28830 IN-SITU TRANSFORMATION OF Fe_3C TO Mo_2C IN IRON–MOLYBDENUM–CARBON ALLOYS. Raynor, D.; Whiteman, J. A.; Honeycombe, R. W. K. J. Iron Steel Inst. (London), 204: 1114-16(Nov. 1966).

The early stages of the decomposition of martensite in a high-purity Fe–Mo–C alloy have been examined by thin-foil electron microscopy. The first precipitate observed is cementite, which is present even in the as-quenched state. Later Mo_2C is seen to nucleate on dislocations, martensite needle boundaries and at the ferrite/cementite interface. Mo_2C nucleated at the Fe_3C interface or at needle boundaries grows more rapidly than that nucleated at a site where more rapid growth can occur. The distribution of cementite particles has a considerable influence on the size and distribution of subsequent Mo_2C precipitates. (Rev. Metal Lit.)

28831 CRYSTALLOGRAPHY OF DEFORMATION TWINNING IN ALPHA-URANIUM. Bevis, M. (Univ. of Liverpool). J. Nucl. Mater., 26: 235-7(1968).

A table is given of twinning modes with shear strains less than unity which restore all or one-half of α-uranium Bravais lattice points in an orientation other than those determined by the classical orientation relations. The detailed analysis of possible single twinning shears in the α-uranium Bravais lattice is completed. References to the previous work are given. (J.C.W.)

28832 EFFECT OF COPPER ON THE HARDNESS ANISOTROPY OF BERYLLIUM SINGLE CRYSTALS. Tsuya, K. (National Research Inst. for Metals, Tokyo). J. Nucl. Mater., 26: 217-18(1968).

Data on the plastic anisotropy of beryllium-copper alloys, on the basis of the relation between hardness data and anisotropy, are reported. The variation of Knoop hardness on $(11\bar{2}0)$ planes of beryllium and beryllium–5.14 wt % copper alloy is shown. To relate the hardness values with the deformation modes of beryllium, orientation factors were calculated for two indenter orientations, $[10\bar{1}0]$ and [0001] direction. (J.C.W.)

28833 INFLUENCE OF BORON ON CRYSTALLIZATION OF α-PHASE ALLOYS OF URANIUM. Foure, M. (CERCA, Romans, France); Lauque, J. P.; Colombie, M.; Decours, J. J. Nucl. Mater., 26: 185-203(1968). (In French).

The influence of boron on the crystallization of the α phase in various uranium alloys is discussed. Very small additions of boron lead to pronounced refinement of the α grain size even for quite slow cooling rates (10 to 20°C/min). This refinement is attributed to the presence of UB_2 precipitates which act as heterogeneous nuclei for the $\beta \rightarrow \alpha$ transformation; they exert this function the more effectively, the more highly dispersed they are. A detailed study was made of the behavior of dilute alloys with 0.2 to 0.4 at. % of molybdenum with 100 ppM of boron, in both isothermal transformation and continuous cooling. Studies were made of dilute USi, UCr, UMoAl, UMoSi, UMoSn, other alloys, and technical uranium; so long as the boride particles were finely distributed, grain refinement resulted. The addition of small quantities of boron did not appreciably alter the mechanical properties. (auth)

28834 LATTICE AND GRAIN-BOUNDARY DIFFUSION OF URANIUM IN ThO_2 AND ThO_2–UO_2 SOLID SOLUTION. Furuya, H. (Tohoku Univ., Sendai). J. Nucl. Mater., 26: 123-8(Apr. 1968).

Lattice and grain-boundary diffusion of U in ThO_2 and ThO_2–UO_2 (1:1) solid solution were measured by using ^{237}U as a tracer, and the sectioning method. Pellets used were sintered at 2300°C for 2 hr and had a density >98% of theoretical and an average grain size over 60 mμ. It was found that the activity energy of lattice diffusion of U in ThO_2 was smaller than that in the ThO_2–UO_2 solid solution. (P.G.C.)

28835 STRUCTURAL INVESTIGATIONS IN THE ZIRCONIUM–BISMUTH SYSTEM AND SEVERAL QUASIHOMOLOGOUS ALLOYS. Eberle, Dietrich; Schubert, Konrad (Max-Planck-Institut fuer Metallforschung, Stuttgart). Z. Metallk., 59: 306-8(Apr. 1968). (In German).

The atom parameters of the phases $ZrSb_2$, $HfSb_2$(r), $ZrBi_2$, and V_3Sb_4 have been determined and the structure types are discussed with respect to the underlying binding relation. (auth)

28836 PHASE DIAGRAMS OF THE TERBIUM– AND YTTERBIUM–MERCURY SYSTEMS. Kirchmayr, Hans Rudolf; Lugscheider, Walter (Technische Hochschule, Vienna). Z. Metallk., 59: 296-7(Apr. 1968). (In German).

By differential-thermal analysis and x-ray investigations of amalgams, the phase diagrams of terbium–mercury and ytterbium–mercury have been obtained. In these systems, similar to other Re–Hg systems, the compounds $REHg_4$, $REHg_3$, $REHg_2$, and REHg are present. (auth)

28837 AN ELECTRON MICROSCOPY INVESTIGATION OF THE OMEGA PHASE IN THE ZIRCONIUM NIOBIUM SYSTEM. Yaffe, Paul Ellison. Cleveland, Case Inst. of Tech., 1967. 151p.

Thesis.

The athermal and isothermal omega transformations were studied with brightfield and precision darkfield techniques in Zr-12%, 17% and 25% Nb alloys. The athermal omega was found to exist as planar precipitates consistent with $\{112\}_{bcc}$ and $\{110\}_{bcc}$ habit planes and is approximately 100 Å in diameter and 20 Å in thickness. The density of the athermal particle is of the order of 10^{18} particles/cc and the particles tend to align parallel to one another in $\langle 112\rangle_{bcc}$ and $\langle 110\rangle_{bcc}$ beta directions. The difference between the athermal omega reaction and the conventional martensitic reaction is emphasized and the athermal transformation is considered as a second order transformation. During the early stages of aging in the 17% alloy athermal omega forms as the specimen cools from the aging temperature resulting in mixtures of isothermal and athermal omega at room temperatures. In the 12% alloy the isothermal omega particles are initially plate-shaped with the same habit plane and alignment directions which are characteristic of the athermal omega. As the aging continues, the alignment of the particles persists but there is a transition from plates to polyhedra and finally to irregularly shaped particles approximately 500 × 1000 Å. (Diss. Abstr.)

28838 INTERNAL FRICTION STUDY OF ALLOTROPIC TRANSFORMATIONS. Selle, James Edward. Cincinnati, Univ. of Cincinnati, 1967. 138p.

Thesis.

Internal friction and relative shear modulus measurements of Pu, U, and Co demonstrated the feasibility of these techniques for the determination of transformation mechanisms. A low frequency inverted torsion pendulum was used. Transformations known to proceed by a shear mechanism which were studied included the $\alpha \rightarrow \beta$, $\beta \rightarrow \alpha$ and $\delta \rightarrow \gamma$ transformations in Pu and the $\alpha \rightarrow \beta$ and $\beta \rightarrow \alpha$ transformations in Co. These transformations are characterized by the fact that the internal friction values above and below the transformation temperature are approximately equal. Also, the relative shear modulus changes over a broad temperature range. Transformations known to proceed by a diffusional mechanism which were studied included the $\beta \rightarrow \gamma$, $\gamma \rightarrow \beta$, and $\gamma \rightarrow \delta$ transformations in Pu and the $\alpha \rightarrow \beta$ and $\beta \rightarrow \alpha$ transformations in U. For these transformations the internal friction values on both sides of the transformation temperature are considerably different and the relative shear modulus changes over a very narrow temperature range of one to three degrees centigrade. These results are considered in terms of the analogy between shear transformations and twinning. The gradual change in the relative shear modulus is explained as a manifestation of the athermal nature of shear transformations. Quantitative calculations based on background internal friction constants were made for Pu and the conclusions drawn from these calculations are consistent with those obtained from relative shear modulus and internal friction data. These observations are extended to the remaining transformations of Pu and U, and mechanisms for these transformations have been established for the first time. Trans-

formations found to occur by a shear mechanism are the $\delta \rightarrow \delta'$ and $\delta' \rightarrow \epsilon$ transformations in Pu. Transformations found to occur by a diffusional mechanism are the $\epsilon \rightarrow \delta'$ and $\delta' \rightarrow \delta$ transformations in Pu and the $\beta \rightarrow \gamma$ and $\gamma \rightarrow \beta$ transformations in U. The internal friction of a given phase is found to be a function of the mechanism by which that phase is formed. A phase formed by a shear mechanism has a considerably higher internal friction than the same phase formed by a diffusional mechanism. Apparently, an increased defect concentration results from a shear transformation. Erroneously high values for internal friction are found if measurements are made without sufficient annealing time at temperature. This internal friction decreases with time, suggesting a vacancy diffusion mechanism. Expressions are derived to obtain activation energies for vacancy migration, vacancy formation and self-diffusion. Activation energies for self-diffusion calculated for δ Pu and α U agree to within 11% when compared with available literature values. These results suggest that internal friction can be used as a technique for determining the activation energies for vacancy migration, vacancy formation and self-diffusion. (Diss. Abstr.)

28839 EXAMINATION OF STEELS FOR SLAG INCLUSIONS. A Communication from the Jernkontoret Research Organization, Stockholm, Almqvist and Wiksell, 1966. 66p. Sw. Crs. 15.00. (NP-17370).

The methods and experience already available were assessed, and it was concluded that none of the known techniques meet the requirements which must be imposed. An account of methods which were evaluated in practice and may now be recommended for general use is presented. A survey of the problems on inclusion assessment and recommendation of methods suited to the various needs met in practice are given. The object was to find methods suited both to routine tests and research purposes. The techniques recommended may be adopted to different conditions. They are published as a manual which contains information on: methods of inclusion assessment; routine assessment of microinclusions content in steel according to the size measurements and point counting; microscope inclusion assessment by drawing method; the step-down test; application of the magnetic powder test for the indication of inclusion stringers in the step-down test; the bue fracture test; recommendations for isolation of nonmetallic inclusions in steel; and assessment of inclusion contents by chemical analysis of sulfur and oxygen. (Sweden)

28840 SOLID STATE PHASE EQUILIBRIA IN COBALT RICH Co-WC ALLOYS. Giamei, Anthony Francis Paul. Evanston, Ill., Northwestern Univ., 1967. 340p.

Thesis.

A method is presented for the determination of the orientation of a single grain in a polycrystalline sample by a one surface analysis when transformation markings are present. The results are correlated with x-ray diffraction data. The M_d temperature is also located with respect to room temperature as a function of alloy composition. Qualitative and semiquantitative x-ray diffraction are used to establish phase equilibria at 750 to 1200°C. Several isothermal sections in this temperature range are presented as well as the Co-WC section. The kinetics of the equilibrium reactions leading to the formation of the hexagonal matrix phase are presented. The volume fractions are determined by a unique analytical method which utilizes all of the available diffraction information. This method is an iterative procedure which leads to considerable improvement in the accuracy of the determination. An expansion of the basic method is presented for the determination of solubility. A complete kinetic theory is presented for the rates of formation and depletion of transition phases. The observed and theoretical rates are compared. Correlations of the kinetic data with alloy macrohardness, matrix microhardness, quantitative metallography and alloy density are presented. The various measurements are compared with the model for the kinetics of the peritectoid reaction. Specific conclusions are presented for the Co-WC and related systems. Some considerations are also given to the more general implications of the present work for cobalt base alloys. (Disser. Abstr.)

28841 SCHOTTKY DEVIATIONS FROM TANTALUM SINGLE CRYSTALS. Dubas, Michael Stephen. St. Louis, St. Louis Univ., 1967. 219p.

Thesis.

Selected single crystals (length, 33-mm approximately; grown in 0.005-in polished pure tantalum wires) were mounted such that the (111) emission currents from 2.9 to 27° of the perimeters of the wires were measured. Pressures were held in the 10^{-10} torr region by ion pumping. Schottky deviation data were obtained for electrostatic fields up to 1.7×10^5 volt-cm^{-1}, T = 1520°K. With respect to phase and amplitude, the observed deviation curves lie approximately half-way between the modified Guth-Mullin curves used by Juenker and Cutler-Gibbons. Room temperature emission measurements were obtained for both polished single crystals and an unpolished polycrystalline specimen. All specimens exhibited a room temperature emission for electrostatic fields of approximately 1×10^5 to 1.8×10^5 volt-cm^{-1}. Semilog Fowler-Nordheim field emission plots yielded approximate straight lines of slopes two orders of magnitude lower than expected. This discrepancy would disappear if the actual electrostatic fields were two orders of magnitude larger than measured, due for example to a roughness of the emitter surface equivalent to emitter point radii of about $1/200$ of the nominal specimen radius. Further calculations suggested that roughness of the emitter surface could contribute to phase shift and amplitude discrepancies between theoretical and observed experimental Schottky deviations. Unsuccessful attempts were made to observe photoelectric Schottky deviations. It is concluded that the field emission due to emitter surface roughness would dominate and so obscure the photoelectric Schottky deviations. This same field emission obscured thermionic deviations when emitter temperatures were not sufficiently elevated. (Disser. Abstr.)

Radiation Effects

Refer also to abstracts 28735, 30159, and 30388.

28842 (AERE-R-5747) FIELD ION MICROSCOPE EXAMINATION OF HEAVY ION RADIATION DAMAGE IN IRIDIUM. I. EXPERIMENTAL TECHNIQUE. Hudson, J. A.; Nelson, R. S.; Ralph, B. (Atomic Energy Research Establishment, Harwell (England)). Mar. 1968. 12p. Dep. CFSTI, UK.

The investigation of heavy ion radiation damage in iridium by field-ion and electron microscopy is discussed. An experimental arrangement is described in which prepared field ion microscope specimens may be bombarded 'in situ' by ions from a heavy ion accelerator. Some early results are described of specimens bombarded with Ar^+ and Xe^+ ions in the 50 to 100 keV energy range at liquid nitrogen and room temperature. (auth)

28843 (DUN-SA-22) MECHANICAL PROPERTIES OF IRRADIATED 1100 H18 ALLOY ALUMINUM. Young, J. R. (Douglas United Nuclear, Inc., Richland, Wash.). Mar. 10, 1966. Contract AT(45-1)-1857. 13p. Dep. CFSTI.

Samples of 1100 H18 alloy aluminum were irradiated to integrated neutron fluxes of up to 2×10^{21} fast neutrons (>1.0 MeV). Measurement of the mechanical properties showed that for irradiations, up to this integrated flux, the yield and ultimate strengths increased by approximately twenty-five percent soon after initiation of irradiation and then remained constant at this higher value, the hardness increased continuously with irradiation, and the elongation increased slightly with irradiation. (auth)

28844 (EURAEC-1751) LA ZONE DE LA TOLE INFLUENCEE THERMIQUEMENT PAR LE SOUDAGE. SON IMPORTANCE DU POINT DE VUE FRAGILISATION DE LA CUVE EN FABRICATION ET EN SERVICE. (The Heat-Affected Zone of the Plate and Its Importance as Regards Vessel Embrittlement During Fabrication and in Service). Sebille, J. (European Atomic Energy Community). Dec. 5, 1966. 36p. (In French). (EUR-3310; CONF-661047-2). Dep. CFSTI.

Work performed under United States-Euratom Joint Research and Development Program.

From Conference of Experts on Recurring Inspection of Nuclear Reactor Pressure Vessels, Pilsen, Czechoslovakia.

Effects of transition temperature on the state of steels are tabulated according to heat treated and non-heat treated. Mechanical properties and structural zones of the steels are determined. Effects of neutron fluxes of 4.5×10^{19} n/cm^2/sec and 3.5×10^{19} n/cm^2/sec are determined. All data are tabulated. 32 references. (M.L.S.)

28845 (WCAP-3677-7) FRACTURE MECHANICS EVALUATION OF REACTOR VESSEL STEELS. Quarterly Progress Report for the Period Ending March 31, 1968. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). Apr. 1968. Contract AT(30-1)-3677. 12p. (EURAEC-2007). Dep. CFSTI.

Work Performed under United States-Euratom Joint Research and Development Program.

An experimental program is being performed to develop and evaluate a fracture mechanics approach using modified Wedge Opening Loading specimens. Progress under the Irradiation and Analysis, and the Pre-Irradiation Testing tasks of the program are reported. The layout for sectioning and the kind of specimens taken from the 12-inch thick plate of SA-533 Grade B Class I steel, are given. (D.L.C.)

28846 RADIATION GROWTH AND SWELLING ANALYSIS OF SOLID FUEL RODS DURING A COMPLETE REACTOR PERIOD. Ma, Benjamin M. (Iowa State Univ., Ames). Nucl. Eng. Design, 7: 181-93(1968).

The strain rates, strains, and stresses resulting from thermal-cycling growth, irradiation growth and irradiation swelling accompanied by high plasticity and internal pressure of fission product gases in long fuel rods during a complete reactor period are determined analytically. From the simple diffusion equation for a nonequilibrium reactor system, an exact solution of neutron flux distribution is expressed by products of Bessel function and exponential time function. From the heat conduction equation with an internal heat source in unsteady state, exact solutions of temperature variation in the fuel rods during positive and negative reactor periods are found. On the basis of some basic assumptions in regard to the properties and yield criterion of the fuel and cladding materials, a physicomechanical analysis for the fuel rod is carried out. Based on the equations derived and the results calculated from a numerical example of a fast reactor, the components of strain rate, strain and stress produced in the fuel rod during the complete reactor period are shown. The effect of combined thermal stresses, pressure stresses and thermal fatigue may cause breach of the cladding and failure of the fuel rod. (auth)

28847 THERMAL STABILITY OF RADIATION PRODUCED DEFECTS IN MOLYBDENUM. Brimhall, J. L.; Mastel, B.; Bierlein, T. K. (Battelle-Northwest, Richland, Wash.). Contract AT(45-1)-1830. Acta Met., 16: 781-8(June 1968).

The microstructural damage and its subsequent recovery in molybdenum, irradiated at 600°C, were studied by quantitative electron microscopy. The microstructure after irradiation consisted of large interstitial loops and smaller clusters within the grains. A zone denuded of interstitial loops, but containing vacancy clusters, was present near grain boundaries. The disappearance during annealing of the large interstitial loops within the grains occurred at a rate equal to that of self-diffusion, as did the growth of the vacancy loops within the denuded zones. The rapid annealing of small clusters within the grains occurred at a rate more nearly equal to that of vacancy migration. (auth)

28848 RADIATION ANNEALING OF DEFORMED MOLYBDENUM SINGLE CRYSTALS. Kravchenko, V. S.; Larikov, L. N.; Plotnikova, N. P. (Inst. of Metal Physics, Kiev). Porosh. Met., Akad. Nauk Ukr. SSR, No. 2, 80-8(Feb. 1968). (In Russian).

Radioinduced deformation of Mo monocrystals was studied using 1.5 to 2 mm thick plates with the surface parallel to (110) plane and irradiated in a VVR-M by slow neutrons, 5×10^{19} n/cm^2. Comparative topographic pictures are given of irradiated and non-irradiated specimens after annealing for 5 hr at 1500°C. (R.V.J.)

28849 STRESS DEPENDENCE OF DISLOCATION VELOCITY IN SINGLE CRYSTAL NIOBIUM. Guberman, H. D. (Oak Ridge National Lab., Tenn.). Acta Met., 16: 713-21(May 1968).

The stress-dependence of dislocation velocity was measured by etching in niobium single crystals grown by an electron-beam floating-zone technique. The velocity-stress relaxation was determined with temperature, purity, and low neutron dose levels as variables. The data can be expressed in all cases by an equation of the form $\bar{v} = (\tau^*/\tau_0)^{m^*}$ where $\bar{v}$ is the average velocity, τ^* is the effective shear stress, and m^* and τ_0 are constants. The exponent m^* was found to increase slightly with decreasing temperature, increase strongly with greater impurity content, and to decrease with neutron irradiation up to 8.3×10^{17} n/cm^2 (E > 1 MeV). Measurements of the strain-rate sensitivity and the stress relaxation indicated that these techniques were unsatisfactory in determining the exponent m^* in the velocity equation. Correlations could be made between the data from etching and mechanical measurements in irradiated samples which suggest that the increase in the upper yield stress upon neutron irradiation is associated with a dynamic resistance to dislocation motion. (auth)

28850 UNIT CELL AND DIMENSIONAL CHANGES IN IRRADIATED SINGLE-CRYSTAL RHENIUM. Kissinger, H. E. (Battelle Memorial Inst., Richland, Wash.). Contract AT(45-1)-1830. Phil. Mag., 17: 871-3(Apr. 1968). (BNWL-SA-1392).

Single-crystal rhenium rods exposed to 2.5×10^{18} and 5×10^{18} n/cm^2 (E > 1 MeV) showed fractional length and lattice parameter changes positive in the a-axis direction and negative in the c-axis direction. The magnitudes of the changes were such that the unit cell volume decreased after an initial expansion, while the crystal volume increased to an apparent saturation value. These results are interpreted as indicating a defect configuration of clustered interstitials and isolated vacancies. (auth) (UK)

28851 RADIATION-INDUCED COHERENCY LOSS IN A Cu-Co ALLOY. Brown, L. M. (Cambridge Univ., Eng.); Woolhouse, G. R.; Valdre, U. Phil. Mag., 17: 781-9(Apr. 1968).

It is shown that there is a size below which a coherent spherical precipitate cannot maintain a dislocation loop at its interface. There is also a size above which the incoherent (i.e. dislocated) state is stable with respect to the coherent state. Experiments in the electron microscope showed that there is a size above which a transition to incohency can occur, but that the observed critical size is bigger than that predicted theoretically. Reasons for this discrepancy are considered. (auth)

28852 CYCLIC DEFORMATION OF NEUTRON IRRADIATED COPPER. Adamson, R. B. (Atomic Energy Research Establishment, Harwell, Eng.). Phil. Mag., 17: 681-93(Apr. 1968). (AERE-R-5595).

Copper single crystals irradiated to a neutron dose of 1.1×10^{18} n/cm^2 (>1 MeV) were cycled between constant plastic elongation limits at room temperature. The general cyclic deformation characteristics were ascertained and some qualitative ideas on the mechanisms of deformation developed. Transmission electron microscopy revealed that channels completely free of irradiation-produced defects were created during the cyclic strain program. The width and spacing of the channels were shown to be a function of the number of cycles. An electron microscope shadowgraph technique was also used to study the exact shape and distribution of surface slip steps and the results are compared to the channel observations. (auth) (UK)

28853 APPLICATION OF THE GENERALIZED THEORY OF YIELDING CREEP TO IRRADIATION CREEP IN ZIRCONIUM ALLOYS. Hesketh, R. V. (Central Electricity Generating Board, Berkeley, Eng.). J. Nucl. Mater., 26: 77-86(Apr. 1968).

The theory of yielding creep, in its generalized form of accelerated thermal creep, is extended to include the temperature, neutron flux and time dependence of irradiation creep. The theory is consistent with data at 78°K and 40°C and with data at 300°C. The growth coefficient, G, of Zircaloy-2 at the respective temperatures is deduced to be 2.3, 1.2 and 1.5. Direct measurement gives $G \approx 1.2$ at ~100°C. If the short term thermal creep behavior continues to reactor lifetimes of 200,000 hr the analysis suggests that linear extrapolation of the irradiation creep rate overestimates the final strain by a factor of five. The insensitivity to neutron irradiation of creep processes which are controlled by diffusion is discussed, e.g., Nabarro-Herring creep, the climb of edge dislocations and jogs in screw dislocations. (auth)

28854 BEHAVIOR OF ELEMENTAL BORON PARTICLES IN COPPER DURING NEUTRON IRRADIATION. Vela, P.; Hardy, J.; Russell, B. (Univ. of Queensland, Brisbane). J. Nucl. Mater., 26: 129-31(Apr. 1968).

Specimens of Cu doped with 0.01 wt % of ^{10}B, partly in solid solution and partly dispersed particles, were irradiated with neutrons at 75 to 500°C to doses between 5×10^{19} nvt and 2×10^{20} nvt and examined by electron microscopy. Inner and outer spheres of damage were observed, comprised of a large number of individual dislocations of the interstitial type. Outer spheres of damage eventually transformed into spheres of He bubbles during annealing at ≈700°C. (P.G.C.)

28855 IN-REACTOR CREEP OF Zr-2.5 AT. PERCENT Nb. Gilbert, E. R. (Battelle Memorial Inst., Richland, Wash.). J. Nucl. Mater., 26: 105-11(Apr. 1968).

Results of tensile tests on heat-treated Zr−2.5 at. % Nb alloys, under constant creep loads both unirradiated and during neutron irradiation are reported. At 300 and 320°C the difference between the in-reactor creep rate and the unirradiated control creep rate shows little if any dependence on stress or temperature. At stress levels between 11 and 14 kg/mm^2 the in-reactor creep rate of Zircaloy-2 is essentially the same as Zr−2.5 at. % Nb at stress levels from 25.6 kg/mm^2 or lower. It is concluded that only at stress levels greater than approximately 20 kg/mm^2 does the Zr−2.5 at. % Nb alloy offer an advantage over Zircaloy-2. The rate-limiting or controlling step in the creep process is most likely the generation of point defects. (P.G.C.)

28856 MEASUREMENTS OF DENSITIES OF URANIUM DIOXIDE AND URANIUM CARBIDE IRRADIATED AT LOW TEMPERATURES. Kingery, W. D.; Kauffmann, Y.; Bruet, M.; de Bernardy de Sigoyer, B. (CEN, Grenoble, France). J. Nucl. Mater., 26: 204-7(1968). (In French).

UO_2 and UC samples were irradiated at liquid nitrogen temperature and then annealed at 21 or 400°C. Density changes during these anneals were measured to a high precision and were compared with the corresponding changes in lattice parameter determined by others. For UO_2, at a dose of 0.86×10^{16} fissions/cm^3, the density changes determined by the two methods were in agreement, but at 0.83×10^{17} fissions/cm^3 the density decrease measured directly exceeds that calculated from parameter changes. It is concluded that interstitials produced by fission damage recombine to form dislocation loops. (auth)

28857 MECHANISMS FOR THE IN-REACTOR CREEP OF ZIRCONIUM ALLOYS. Piercy, G. R. (Atomic Energy of Canada Ltd., Ont.). J. Nucl. Mater., 26: 18-50(Apr. 1968).

Qualitative estimates are made for the various factors that may influence the creep rate of zirconium alloys during reactor irradiation. Comparison of these with experimental measurements indicates that the in-reactor creep rate of cold-worked Zircaloy is due to dislocation climb caused by the supersaturation of vacancies and interstitials that is introduced by irradiation. The effect of an internal stress distribution introduced by radiation growth does not appear to be an important creep mechanism in cold-worked Zircaloy. (auth)

28858 RADIATION-ENHANCED RELAXATION IN ZIRCALOY-4 AND Zr/2.5 WT PERCENT Nb/0.5 WT PERCENT Cu ALLOYS. Kreyns, P. H.; Burkart, M. W. (Westinghouse Bettis Atomic Power Lab., West Mifflin, Pa.). J. Nucl. Mater., 26: 87-104(Apr. 1968). (WAPD-T-2087).

An irradiation enhanced strain relaxation was observed in Zircaloy-4 and Zr/2.5 wt % Nb/0.5 wt % Cu for fast neutron fluxes of 2.4×10^{14} nv > 1 MeV. The effects of several material and test parameters were investigated and the results compared with out-of-pile stress relaxation data using a thermally-activated creep model. It was found that in-reactor relaxation of Zircaloy-4 was temperature and structure sensitive, independent of initial stress, and consistent with an accelerated thermal creep model. (auth)

28859 THE IN-REACTOR CREEP OF COLD-WORKED ZIRCALOY-2 AND ZIRCONIUM-2.5 WT PERCENT NIOBIUM PRESSURE TUBES. Ross-Ross, P. A.; Hunt, C. E. L. (Atomic Energy of Canada Ltd., Chalk River, Ont.). J. Nucl. Mater., 26: 2-17(Apr. 1968).

To assist in the design of the pressure tube as a core component, the creep behavior of cold-worked Zircaloy-2, cold-worked zirconium-2.5 wt % niobium, and heat-treated zirconium-2.5 wt % niobium materials is studied by measuring the inside diameter of reactor pressure tubes during reactor shutdown. The results show a significant increase in creep rate which can be directly related to the fast neutron flux. The equipment and procedures used to measure diametral creep, and the results gained from several experimental pressure tubes in the NRU and NPD reactors, are discussed. The diametral creep rate of a cold-worked Zircaloy-2 pressure tube operating at 270°C, 3×10^{13} n/cm$^2 \cdot$ s (>1 MeV) and 14,000 psi under a transverse to longitudinal stress ratio of 2:1 (closed end tube) is about 1.8×10^{-7}/h, and is about ten times the creep rate out-of-reactor. The effects of stress and temperature are not as well defined as the effect of flux. Results indicate that for tubes operating between 10,000 to 14,000 psi stress, the exponent n in the relation $\dot{\epsilon} = \beta\sigma^n$($\dot{\epsilon}$ = strain rate, σ = stress) is closer to 1 than to the value of about 3 found in the in-reactor uniaxial tests. Results also indicate that the in-reactor creep rate under biaxial stressing is less temperature dependent than under uniaxial stressing. As a first approximation, the equation, creep rate $\dot{\epsilon}_t = 4 \times 10^{-27}\ \sigma_t \phi(T - 160°C)$/hr could be used for cold-worked Zircaloy-2 in the temperature (T) range from 250 to 300°C, hoop stress (σ_t) up to 20,000 psi, and with fast neutron flux (ϕ) up to 3.5×10^{13} n/cm$^2 \cdot$ s (>1 MeV). At present both uniaxially stressed specimens and tube results show the effect of fast flux but there is no direct correlation between them. The creep of cold-worked zirconium-2.5 wt % niobium is accelerated by the fast neutron flux but the rates are about one-third those of cold-worked Zircaloy-2. Results have been obtained at stresses from 15,500 to 23,000 psi at 270 to 285°C and up to 3.1×10^{13} n/cm$^2 \cdot$ s fast neutron flux (>1 MeV). (auth)

28860 UNIAXIAL IN-REACTOR CREEP OF ZIRCONIUM ALLOYS. Fidleris, V. (Atomic Energy of Canada Ltd., Chalk River, Ont.). J. Nucl. Mater., 26: 51-76(Apr. 1968).

Experimental results of 24 uniaxial in-reactor creep tests on various zirconium alloys, covering a range of stresses from 7 to 42 kg/mm^2 and at 200 to 400°C are shown. At 300°C increases in creep rate of up to an order of magnitude have been measured in a fast neutron flux of $0.4-1.2 \times 10^{13}$ n/cm$^2 \cdot$ sec (E > 1 MeV) with specimens of cold-worked Zircaloy-2. The flux induced increases were smaller with cold-worked and heat treated Zr−2.5 wt % Nb and not measurable in annealed Zr. Prior irradiation had no significant effect on creep of Zircaloy-2 and Zr−2.5 wt % Nb in the 10^{-4}/hr range, but significantly reduced the creep rate in the 10^{-5}/hr and higher ranges. The stress dependence of the in-reactor creep rate appears to follow a power law in cold-worked Zircaloy-2 and Zr−2.5 wt % Nb, with a stress exponent of about 3. The temperature dependence of the in-reactor creep rate changes around 350°C in both cold-worked Zircaloy-2 and heat treated Zr−2.5 wt % Nb. Above 350°C the dependence can be expressed by an apparent activation energy of 50 to 60,000 cal/mol, while below 350°C the activation energy value drops to about 20,000 cal/mol. (auth)

28861 IRRADIATION OF FUEL PINS IN INSTRUMENT-EQUIPPED LEAD–BISMUTH CAPSULES. Haefner, H. E. (Kernforschungszentrum, Karlsruhe, Ger.). Kerntechnik, 10: 136-41(Mar. 1968). (In German).

In an initial series of experiments within the framework of the fast breeder fuel element development project, 55 fuel pins contained in lead-bismuth filled Zircaloy-2 capsules were irradiated in the Karlsruhe FR 2 reactor up to a burn-up of 17,000 MWd/t. Reports on the design of the capsules, the difficulties encountered in operation, and the post-irradiation examinations of the capsules in the hot cells are given. Mention is also made of an advanced capsule type suitable for the irradiation of high-power fuel pins. (auth)

28862 FRAGILITE ET EFFETS DE L'IRRADIATION. 10e COLLOQUE DE METALLURGIE, SACLAY LES 23 ET 24 JUIN 1966. (Brittleness and Irradiation Effects. 10th Conference on Metallurgy, Saclay, France, June 23–24, 1966. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay. Paris, Presses Universitaires de France, 1967. 250p. (In French and English). (CONF-660656).

Twenty-six papers are included. A separate abstract was prepared for each of 25 of the papers. For the abstract of the remaining paper, see NSA 19: 20642. (D.L.C.)

For abstracts of individual papers see: 28728, 28863–28882, 28961–28963, and 28972.

28863 IRRADIATION DEFECTS IN METALS. Quere, Y. pp 1-12 of Fragilite et Effets de l'Irradiation. 10e Colloque de Metallurgie, Saclay, France. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay. Paris, Presses Universitaires de France, 1967. (In French).

From 10th Symposium on Special Metallurgy Brittleness and Irradiation Effects, Saclay, France. See CONF-660656.

The nature of radioinduced defects depends on the experimental conditions (particle energy, irradiation temperature...) and also on the type of solid irradiated. In the case of a metal, the analysis involves only point defects and their various agglomerates. In alloys, it also includes order defects. The presence of these defects is easily detected since it affects the physical properties of the solid. Of these, the variations in stored energy, volume, and lattice parameter are among the most useful physical data for the study of point defects. In many cases, however electrical resistivity measurements, easier to perform, are used to evaluate the defect concentration, its initial variation with the irradiation dose, its tendency towards saturation for high doses, and its variation with annealing. However defects are not only studied for their intrinsic interest. Since they change, sometimes radically, the macroscopic properties of samples, their presence in a recurring factor in all studies of damage. It is useful to remember that although some of these effects are harmful—such as hardening due to irradiation, swelling...—others are of great interest to physicists or metallurgists. (auth)

28864 STUDY OF DEFECTS IN IRRADIATED TUNGSTEN BY ELECTRON MICROSCOPY. Brenac, A. pp 13-16 of Fragilite et Effets de l'Irradiation. 10e Colloque de Metallurgie, Saclay, France. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay. Paris, Presses Universitaires de France, 1967. (In French).

From 10th Symposium on Special Metallurgy Brittleness and Irradiation Effects, Saclay, France. See CONF-660656.

Electron microscopy was used to study the defects in tungsten irradiated by two types of particles: fission particles (pf) and fast neutrons. In the case of fission particles, defects are observed from doses of about 10^{13} pf/cm^2 upwards. The annealing of radioinduced defects was studied by tempering at different temperatures. Fast neutron irradiation up to doses of about 10^{18} n/cm^2/sec produces no defects detectable with the microscope. (auth)

28865 STUDY OF DEFECTS PRODUCED BY NEUTRON IRRADIATION AT 78°K IN ALUMINIUM–LITHIUM ALLOYS. Pissavy, Jean-Claude; Bonjour, Emmanuel; Hillairet, Jacques; Delaplace, Jean. pp 17-25 of Fragilite et Effets de l'Irradiation. 10e Colloque de Metallurgie, Saclay, France. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay. Paris, Presses Universitaires de France, 1967. (In French).

From 10th Symposium on Special Metallurgy Brittleness and Irradiation Effects, Saclay, France. See CONF-660656.

Aluminum alloys containing between 1.3 and 3.3 at. % of lithium were irradiated at 78°K in neutron flux at doses between 6×10^{17} and 1×10^{19} fast n/cm^2. The electrical resistivity, measured at

78°K, is used to follow the total quantity of defects produced by irradiation. A saturation effect is observed for the highest doses. In addition, the excess of resistivity observed is much greater than that obtained in pure aluminum. The recovery of resistivity excess studied by means of isochronal annealings takes place in three stages between 77 and 340°K. Only one of these stages exists in pure aluminum. Measurements of the energy released during the annealing of irradiated samples show the same effects as the annealing curves obtained by resistivity and confirm their amplitude. They also supply quantitative data on the energies released during the different stages of recovery. In addition, if ^{6}Li enriched samples are used, an appreciable amount of helium can be introduced into these alloys as a result of a nuclear reaction on this isotope. Precipitation of this helium seems to be responsible for a stage situated at around 240°K. Electron microscopy has shown the presence of bubbles in strongly irradiated samples annealed at room temperature. In the discussion the effects observed are compared with those existing in pure aluminum. The interpretation is made in terms of interactions between the vacancies and interstitials of Al with the element in solution. (auth)

28866 STUDY OF DEFECTS PRODUCED IN BERYLLIUM BY IRRADIATION AT LOW TEMPERATURE. Nicoud, Jean-Claude; Delaplace, Jean; Hillairet, Jacques. pp 27-39 of Fragilite et Effets de l'Irradiation. 10e Colloque de Metallurgie, Saclay, France. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay. Paris, Presses Universitaires de France, 1967. (In French).

From 10th Symposium on Special Metallurgy Brittleness and Irradiation Effects, Saclay, France. See CONF-660656.

Samples of beryllium with an overall impurity content of about 0.15% were irradiated at low temperature. The irradiations were carried with either neutrons at liquid nitrogen temperature or electrons at liquid hydrogen temperature. The creation of defects and their subsequent annealing were studied by electrical resistivity measurements. The concentration of defects increase with the integrated flux of incident particles and with the energy of these particles. During isochronous annealings, four stages of recovery are observed between 20°K and room temperature. After annealing at room temperature the initial resistivity excess is recovered to more than 95%. Isothermal annealings were performed in the different stages between 77°K and room temperature. No simple kinetics were observed. The activation energy measured during the annealing of the defects varies from 0.45 eV around liquid nitrogen temperature to 0.85 eV at about room temperature. The results obtained with beryllium are compared in the discussion with those published for other metals. (auth)

28867 RECOVERY OF ELECTRON AND NEUTRON IRRADIATED F.C.C. METALS. Schumacher, D. pp 49-53 of Fragilite et Effets de l'Irradiation. 10e Colloque de Metallurgie, Saclay, France. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay. Paris, Presses Universitaires de France, 1967.

From 10th Symposium on Special Metallurgy Brittleness and Irradiation Effects, Saclay, France. See CONF-660656.

The present knowledge of recovery phenomena in a number of electron and neutron irradiated fcc metals is briefly reviewed. Particular attention is paid to the question of free defect migration below recovery stage III, and to the fine structure of stage III. Recent experiments at the Munich reactor (Wenzl et al.) and at the Northwestern University, Illinois (Kauffman et al.) indicate that in copper and in aluminum the substage peak temperatures in stage I do not depend on the concentration of irradiation produced defects. A model proposed by v. Jan is outlined to account for these experiments in terms of correlated recombination of various configurations of Frenkel pairs below stage III and of free interstitial migration in stage III. (auth)

28868 SPONTANEOUS RECOMBINATION OF INTERSTITIALS AND VACANCIES IN NEUTRON IRRADIATED F.C.C. METALS. Wenzl, H. pp 55-6 of Fragilite et Effets de l'Irradiation. 10e Colloque de Metallurgie, Saclay, France. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay. Paris, Presses Universitaires de France, 1967.

From 10th Symposium on Special Metallurgy Brittleness and Irradiation Effects, Saclay, France. See CONF-660656.

The spontaneous recombination of an interstitial, lying within a certain volume V_r around a vacancy, with this vacancy influences both the approach to saturation of the defect concentration during irradiation at 4°K and the annealing behavior after irradiation. Values of these recombination volumes V_r can be calculated from measurements of the electrical resistivity change during irradiation at 4°K in the core of the Munich Research Reactor FRM and from measurements of the stage III annealing in low-temperature neutron and electron irradiated samples. The irradiation experiments yield approx. 250 atomic volumes, the annealing measurements approx. 50 atomic volumes for V_r in aluminum, the difference being due to various additional recombination processes of defects within the displacement cascade. Details of the elementary processes during irradiation and annealing are discussed. (auth)

28869 RECOVERY OF DEFECTS CREATED IN PURE ALUMINUM BY NEUTRON IRRADIATION. Frois, C.; Dimitrov, O. pp 57-62 of Fragilite et Effets de l'Irradiation. 10e Colloque de Metallurgie, Saclay, France. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay. Paris, Presses Universitaires de France, 1967. (In French).

From 10th Symposium on Special Metallurgy Brittleness and Irradiation Effects, Saclay, France. See CONF-660656.

The recovery of very pure aluminum, irradiated with fast neutrons at liquid nitrogen temperature, was studied by means of electrical resistivity measurements at 20.3°K. An attempt was made to determine the influence of the initial defect concentration on the recovery kinetics. The irradiation doses range from 1.5×10^{16} to 2.7×10^{18} fast neutrons per cm^2. Isochronal annealing curves (60 mn every 15°) and differential curves show that the irradiated metal recovers almost completely in two main stages below room temperature. At this temperature only a residue of the order of one % of the initial resistivity excess remains. The first recovery stage lies at around 100°K. Its position does not seem at a first approximation to depend on the irradiation conditions. Its relative amplitude decreases as the dose rises, and it is no longer detectable as an individual stage when the dose reaches 2.7×10^{18} n/cm^2. The second peak of the differential curve, the form of which is simple at the highest irradiation doses (above 10^{17} n/cm^2) broadens, divides progressively into two parts and moves towards high temperatures (196 to 229°K) as the dose decreases. This division into two substages A and B seems to be confirmed by the study of isothermal annealing curves. The defect elimination kinetics, which are complex at the beginning of the process, become second order at the end of the second stage (substage 2 B). The mean activation energy value relative to the second stage of recovery of defects is 0.56 eV. The results of neutron irradiation are compared with those obtained by rolling in liquid hydrogen and by quenching experiments. To establish the identification of the defects involved we studied their elimination in the presence of dislocations introduced after irradiation. (auth)

28870 STUDY AND INTERPRETATION OF THE RECOVERY STAGES OF IRRADIATED ZONE-REFINED NICKEL. Peretto, P.; Bourret, A.; Moser, P.; Minier, C.; Dautreppe, D. pp 63-9 of Fragilite et Effets de l'Irradiation. 10e Colloque de Metallurgie, Saclay, France. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay. Paris, Presses Universitaires de France, 1967. (In French).

From 10th Symposium on Special Metallurgy Brittleness and Irradiation Effects, Saclay, France. See CONF-660656.

Nickel is irradiated either with fast pile neutrons at 27°K or with 2 to 3 MeV electrons at 20°K. The study is carried out by magnetic aftereffect and electrical resistivity measurements, and electron microscope observations. After electron irradiation, three magnetic hysteresis zones are observed in stage I. This stage I is made up of several sub-stages of electrical resistivity recovery: I_B, I_C, I_D, and I_E, named from analogy with the case of copper. The magnetic aftereffect zones disappear during substages I_B, I_C and I_E, respectively. From a study based on the dynamics of Frenkel pair creation, substages I_B, I_C, and I_D, can be attributed to the recombination of adjacent vacancy-interstitial pairs, the interstitial associated with each substage occupying particular sites beside the vacancy. According to the magnetic after effect results, substage I_E is associated with the free interstitial which is necessarily in the dissociated form (split configuration). Another magnetic aftereffect zone in stage II is attributed to di-interstitials. During stage II not only are di-interstitials formed but also more complex agglomerates of interstitials when the irradiation is performed with neutrons. These agglomerates, the size of which develops continuously in the course of stage II, give rise to an itinerant hysteresis zone. During stage III they undergo a change in structure. An electron microscope study of the size distribution leads to an interpretation of stages III and IV in agreement with the magnetic aftereffect and electrical resistivity results. Finally, by electron microscopy in combination with measurements of mechanical properties, it is possible to begin an interpretation of stage V. (auth)

28871 ELECTRON IRRADIATION OF URANIUM AT 7°K. Jousset, J.-C.; Lucasson, A.; Lucasson, P. pp 75-8 of Fragilite et Effets de l'Irradiation. 10e Colloque de Metallurgie, Saclay, France. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay. Paris, Presses Universitaires de France, 1967. (In French).

From 10th Symposium on Special Metallurgy Brittleness and Irradiation Effects, Saclay, France. See CONF-660656.

Uranium purified by zone melting was irradiated at 7°K by 1.7 MeV electrons. The electrical resistivity variation was measured on two 20-micron-thick samples. The curves obtained, representing resistivity increase as a function of the electron flux showed a positive curvature at the beginning; a model is proposed to explain this phenomenon. Annealings were also carried out, and these confirm the existence of stages II and III observed after quenching the uranium from 100°K upwards. (auth)

28872 DISLOCATION ARRANGEMENTS IN IRRADIATED COPPER MONOCRYSTALS. Worzala, J. F. pp 121-30 of Fragilite et Effets de l'Irradiation. 10e Colloque de Metallurgie, Saclay, France. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay. Paris, Presses Universitaires de France, 1967.

From 10th Symposium on Special Metallurgy Brittleness and Irradiation Effects, Saclay, France. See CONF-660656.

The arrangement and density of dislocations created during the deformation of irradiated copper monocrystals are studied by traction. Monocrystals suitable oriented for easy slip were irradiated at three dose levels (5×10^{16}, 5×10^{17}, and 5×10^{18} nvt). After deformation, the monocrystals are studied by the notch impact technique and by electron microscopy. The elastic limit coincides with the appearance of slip bands. The dislocation density in these bands is proportional to the irradiation dose. Deformation progresses by the emission of new dislocations adjacent to these bands. Broadening of the bands can be the result of a cross-slip caused by local stresses. Easy slip ends when the whole sample has reached a dislocation density equal to that observed in the initial bands. These observations appear to be compatible with Seeger's theory of hardening by irradiation. (auth)

28873 CONTRIBUTION TO THE STUDY OF THE INFLUENCE OF IRRADIATION BY NEUTRONS ON SLIP DEFORMATION MECHANISMS IN POLYCRYSTALLINE IRON. Milasin, N.; Malkin, J. pp 131-8 of Fragilite et Effets de l'Irradiation. 10e Colloque de Metallurgie, Saclay, France. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay. Paris, Presses Universitaires de France, 1967. (In French).

From 10th Symposium on Special Metallurgy Brittleness and Irradiation Effects, Saclay, France. See CONF-660656.

The theory of thermally activated slip was used to determine the slip mechanism and its modification by irradiation. By differential traction and relaxation on wires (ϕ 0.6) the apparent activation volumes and energies were measured at 77 to 300°K. The internal shearing stress was determined, after which the curves Va (τ^*) and Qa (τ^*) were plotted (τ^* = effective shearing stress). For non-irradiated iron the results are in good agreement, between 80 and 270°K, with the theoretical curves given by Dorn and Rajnak in their analyses of the mechanism of germination and growth of double kink in Peier's valleys. Above 270°K the increase in the activation volume is much greater than that foreseen by the theory. Two hypotheses are possible: a) a second mechanism connected with impurities comes into play above 270°K. b) Dorn's theory is no longer valid for low effective stresses (in this stress range the results agree with Seeger's theory, which predicts an activation volume proportional to $1/\tau^*$). The influence of irradiation is as follows: The internal stress τi is increased by irradiation defects, and this increase is the main source of hardening. Up to 200°K the curve Va (τ^*) is the same for irradiated and non-irradiated iron, which implies that the same mechanism is involved. On the other hand, above 200°K the activation volume is greater than that of non-irradiated iron. Irradiation defects, or some part of the defects, therefore act in this temperature range as obstacles overcome by thermal activation and are responsible for the additional hardening observed. (auth)

28874 INFLUENCE OF COMPOSITION ON THE BRITTLENESS OF PURE IRRADIATED IRON. Castagna, M.; Rossi, F. S.; Sebille, J. pp 139-48 of Fragilite et Effets de l'Irradiation. 10e Colloque de Metallurgie, Saclay, France. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay. Paris, Presses Universitaires de France, 1967. (In French).

From 10th Symposium on Special Metallurgy Brittleness and Irradiation Effects, Saclay, France. See CONF-660656.

Earlier publications have described the changes in the mechanical properties of iron samples specially prepared to show up the effect of nitrogen and carbon interstitials and of killing elements. The material studied consisted of Armco iron melted and cast under vacuum, deoxidized in various ways (with Al, Si, Ti) to produce materials differing especially in state of aggregation of the oxygen, carbon and nitrogen present. The studies included an examination of the changes in the parameters of Petch equation before and after irradiation, the purpose being to establish their dependence on the defects introduced and on the interstitials present in the original material. Traction tests were carried out on samples irradiated at variable fluence (from 5×10^{17} to 1.4×10^{19} nvt (>1 MeV)) and showed the close dependence which exists between the damage produced and its recovery on the one hand, the composition of the samples and the state of aggregation of the interstitials present on the other. The results of resilience measurements carried out on these materials irradiated at these fluxes are reported. A damage threshold was observed and measured by shock tests at a fluence of about 2×10^{18} nvt which would depend strictly on the composition of the material. A number of resilience measurements on irradiated samples subjected to a thermal annealing treatment confirmed also that the recovery of damage depends on the composition of the material. (auth)

28875 EVALUATION OF EMBRITTLEMENT OF STEEL BY NEUTRON RADIATION FROM THE ATTENUATION OF STRESS-WAVES. van Elst, H. C. pp 149-58 of Fragilite et Effets de l'Irradiation. 10e Colloque de Metallurgie, Saclay, France. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay. Paris, Presses Universitaires de France, 1967. (In French).

From 10th Symposium on Special Metallurgy Brittleness and Irradiation Effects, Saclay, France. See CONF-660656.

A method to evaluate the embrittlement by a method using small specimens (Ca 0.1 cm^3) was developed. These specimens are submitted to stress time endurances of ca 100 kgf/mm^2 peak value and 5 μsec half value time, which are similar to those occurring at the tip of a running brittle fracture, as e.g. in the Robertson test. This could be concluded from high speed photographic and electronic recordings of the detailed propagation of a brittle fracture. In the so-called "split Hopkinson bar" experiment, these stress time performances are communicated to the specimens and their energy absorption as a function of temperature found from the recorded attenuation of the applied stress wave. The shift of this energy absorption versus temperature curve to higher temperatures after irradiation allows one to indicate the increase of the transition temperature. The specimens can be cut from a tensile bar (of 6 mm diameter) which is mounted in the (boiling water or pressurized water) reactor vessel and loaded by its pressure to a constant stress, like the pressure vessel itself, even if creep occurs, by a suitable bellows device, requiring practically no extra room. Generally, the decrease in energy absorption after irradiation is more clearly detectable than the increase of the transition temperature, which however can be estimated fairly well. A sometimes occurring strong increase in energy absorption with temperature for the steel outside the transition region after large radiation doses in this stresswave attenuation test complicates the interpretation. (auth)

28876 CONTRIBUTION TO THE STUDY OF THE GROWTH OF BUBBLES FORMED IN METALS UNDER IRRADIATION. Levy, V.; Perraillon, B.; Espinasse, J.; Sejourne, S. pp 159-70 of Fragilite et Effets de l'Irradiation. 10e Colloque de Metallurgie, Saclay, France. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay. Paris, Presses Universitaires de France, 1967. (In French).

From 10th Symposium on Special Metallurgy Brittleness and Irradiation Effects, Saclay, France. See CONF-660656.

An irradiation effect of considerable practical importance is the coalescence into bubbles of the rare gas atoms formed under supersaturation conditions in solids by nuclear reaction. The nucleation and growth of rare gas bubbles were studied on neutron irradiated Al–Li alloys. The various mechanisms proposed to explain the formation of the bubbles, i.e., diffusion of vacancies and gas atoms, migration of bubbles, were examined. The influence of certain factors on nucleation and growth has been established. These are: gas concentration; temperature and pressure; distribution and number of lattice defects; and external forces such as stress, temperature gradient and electric field. (auth)

28877 BREAKAWAY SWELLING IN IRRADIATED URANIUM. Speight, M. V.; Harris, J. E. pp 171-4 of Fragilite et Effets de l'Irradiation. 10e Colloque de Metallurgie, Saclay, France. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay. Paris, Presses Universitaires de France, 1967.

From 10th Symposium on Special Metallurgy Brittleness and Irradiation Effects, Saclay, France. See CONF-660656.

The theories for the mechanism of breakaway swelling are examined critically. It is concluded that although the late stages of the process may occur by a creep fracture mechanism, it is necessary to invoke the presence of fission gas bubbles to account for nucleation of the voids. (auth)

28878 ELECTRON MICROSCOPE STUDY OF HELIUM BUBBLES IN IRRADIATED BERYLLIUM. Frenkel, J.-M.; Erler, J.; Didout, G.; Weisz, M. pp 175-84 of Fragilite et Effets de l'Irradiation. 10e Colloque de Metallurgie, Saclay, France. Gif-

sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay. Paris, Presses Universitaires de France, 1967. (In French).

From 10th Symposium on Special Metallurgy Brittleness and Irradiation Effects, Saclay, France. See CONF-660656.

The fast neutron irradiation of beryllium produces helium atoms which precipitate as bubbles if the irradiation temperature is sufficiently high (>450°C). The form of these bubbles was studied and their distribution determined for different irradiation doses and temperatures. Inside the grains of beryllium irradiated under conditions such that the helium bubbles formed are close to equilibrium (590 to 650°C), these bubbles take the form of hexagonal prisms with the base parallel to the (0001) plane of Be and the faces parallel to the $(11\bar{2}0)$ planes, prismatic planes of the second kind. The ratio between the height of this prism and the side of its base is about 0.5. This result is used to calculate the ratio of the Be surface energies along the base plane and the prismatic planes of second kind: $\gamma 0001/\gamma 11\bar{2}0 \sim 0.3$; characteristic of the anisotropy of the metal. In the case of irradiation at lower temperatures, a heterogeneous nucleation of bubbles on the dislocations is observed after annealing. (auth)

28879 IRRADIATION CREEP IN NON-FISSILE METALS. Hesketh, R. V. pp 185-6 of Fragilite et Effets de l'Irradiation. 10e Colloque de Metallurgie, Saclay, France. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay. Paris, Presses Universitaires de France, 1967.

From 10th Symposium on Special Metallurgy Brittleness and Irradiation Effects, Saclay, France. See CONF-660656.

Both isotropic and anisotropic metals creep during neutron irradiation, and the mechanisms appear to differ completely from those of thermal creep. Both transient and steady creep are observed, and they are probably independent of each other. The dependence of the transient on stress, stress changes, temperature, flux, and dislocation concentration is consistent with a process of dislocation climb. Recent experimental results are discussed. The steady creep is remarkable for its consistency from specimen to specimen and for the materials in which it occurs. It is of some importance in zirconium alloys. Some of its parameters are discussed and an explanation offered. (auth)

28880 INFLUENCE OF IRRADIATION ON THE MECHANICAL PROPERTIES OF Fe Al 40. Sainfort, G.; Gregoire, J.; Mouturat, P.; Romeggio, M. pp 187-98 of Fragilite et Effets de l'Irradiation. 10e Colloque de Metallurgie, Saclay, France. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay. Paris, Presses Universitaires de France, 1967. (In French).

From 10th Symposium on Special Metallurgy Brittleness and Irradiation Effects, Saclay, France. See CONF-660656.

Neutron-irradiated Fe Al 40 is found to be very brittle when traction tests are carried out from 600°C upwards. Breaking occurs prematurely by intergranular decohesion, and is the result of a combined action of temperature and the deformation at this temperature. An increase in the traction speed does not favor a recovery of ductility because of the special properties of Fe Al 40, already highly sensitive in the non-irradiated state to the speed of deformation at high temperature. The tendency towards brittleness, which can vary in character with the deformation temperature, seems to be a consequence of the reaction $^{10}B(n,\alpha)^{7}Li$. In fact, a decrease in the boron content eliminated it completely for the fluxes involved in this work ($\Phi_{th} \# 10^{20}$ n/cm^2). (auth)

28881 IRRADIATION EMBRITTLEMENT OF NICKEL. MECHANICAL PROPERTIES IN EXTENSION AND CREEP TESTS. Andre, J.-P.; Silvent, A.; Ferrieux, F.; Frenkel, J.; Lemaire, J.; Morgand, P.; Sainfort, G. pp 199-215 of Fragilite et Effets de l'Irradiation. 10e Colloque de Metallurgie, Saclay, France. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay. Paris, Presses Universitaires de France, 1967. (In French).

From 10th Symposium on Special Metallurgy Brittleness and Irradiation Effects, Saclay, France. See CONF-660656.

Samples of nickel of different purities were irradiated at room temperature up to integrated dose of 1.4×10^{20} fast neutrons and 3.5×10^{20} thermal neutrons/cm^2. This irradiation induces a large loss in ductility which: at temperature less than 600°C is mainly due to hardening by "physical" defects, and at higher temperatures, results from the production of helium by (n,α) nuclear reactions. This embrittlement is a function of purity and strain rate. By comparing the behavior of single and polycrystalline specimens, it is shown that the phenomenon has a purely intergranular origin, and this in turn may explain the complex effect of boron additions. (auth)

28882 METHOD FOR STUDYING POINT DEFECTS IN METALS. Budin, Claude; Lucasson, Pierre. pp 227-40 of Fragilite et Effets de l'Irradiation. 10e Colloque de Metallurgie, Saclay, France. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay. Paris, Presses Universitaires de France, 1967. (In French).

From 10th Symposium on Special Metallurgy Brittleness and Irradiation Effects, Saclay, France. See CONF-660656.

Interstitial atoms in metals can be studied by means of combined quenchings and irradiations. Investigations on aluminum and copper were made by electrical resistivity measurements at liquid nitrogen temperature. After preliminary annealing or quenching treatment, aluminum was irradiated at −170°C by 1.45 MeV electrons. The recovery of the electrical properties was then studied by isochronal and isothermal annealings. The results are as follows: (1) Stage III (corresponding to the annealing of radioinduced defects) obeys a 2nd order reaction. (2) For equivalent values of the resistivity increases, the points of inflexion of the isochronal curves corresponding to the annealing of vacancy defect (induced by quench) lie in the temperature scale 50° higher than those of stage III. (3) A preliminary quench shifts the middle point of the stage III isochronal curves towards low temperatures. This result shows that stage III is due to a reaction of the type: I(mobile) + V(at rest) → O. Together with the defective production curves, the isochronal curves also show that: (1) The resistivity increase corresponding to stage II is proportional to the electron flux, and a preliminary quench, has no effect neither on this increase nor on the stage II. (2) The resistivity increase corresponding to stage III is given by $\Delta\rho = A(1 - e^{-B\Phi})$ and the resistivity increase per incident electron is the smaller the stronger the quench. Isothermal anneals give the following value for the migration energy of mobile interstitial atoms in stage III: E = 0.58 + 0.03 V. From the experimental results, it is possible to make an estimate of the ratio of the specific resistivity of an interstitial to that of a vacancy. A similar but preliminary study has been carried out on copper. Only qualitative results have been obtained. An isochronal study of the recovery of the electrical properties shows that stage III is due to a reaction of the type: I(mobile) + V(at rest) → O. (auth)

Ceramics and Cermets

Refer also to abstracts 28728, 28730, and 30155.

28883 USE OF LANTHANIDE OXIDE NEUTRON ABSORBERS IN PRESSURIZED WATER REACTORS. Leitten, C. F. Jr. (Union Carbide Corp., Indianapolis); Beaver, R. J. Nucl. Appl., 4: 399-417(June 1968).

Recent advancements have stimulated interest in lanthanide compounds as neutron absorbers. Specific fabrication procedures were developed for incorporating chemically stable europium oxide in stainless steel-base neutron absorbers. The irradiation of europium oxide–stainless steel base absorbers to neutron absorptions as high as 6×10^{21}/cm^3 resulted in no deleterious effects. The excellent performance of the europium oxide-stainless steel combination in the control rods of the SM-1 and SM-1A reactors further demonstrated their potential in pressurized water reactors. Arc fusion was found superior to conventional high-temperature heat treating for the production of either bulk or dense dispersoids of the lanthanide oxides. Europium molybdate and titanate are attractive compounds that resist attack by water. In addition to its superior resistance to corrosion by water at high temperature, europium molybdate has a substantial europium density. However, like europium oxide, it is only compatible with stainless steels having low silicon contents. Europium titanate has a lower europium density but acceptable resistance to water and superior compatibility with conventional stainless steels. (auth)

28884 INVESTIGATION OF THE CONDITIONS OF OBTAINING AND EMISSIVE PROPERTIES OF SOME YTTRIUM AND GADOLINIUM BORIDES. Kudintseva, G. A.; Kuznetsova, G. M.; Bondarenko, V. P.; Selivanova, N. F.; Shlyuko, V. Ya. (Kiev Order of Lenin Polytechnic Inst.). Porosh. Met., Akad. Nauk Ukr. SSR, No. 2, 45-53(Feb. 1968). (In Russian).

Optimal conditions are determined for obtaining the powders of yttrium and gadolinium tetra- and hexaborides and their hot pressing. The emissive properties of yttrium and gadolinium hexaborides and tetraborides are investigated. It is shown that yttrium hexaboride is an unstable compound and is decomposed in the process of a cathode work, forming yttrium tetraboride. Yttrium tetraboride and gadolinium borides are more stable. The maximum densities of the current obtained at 1600°C and the field tension of 5500 V/cm are 0.6 and 1.1 A/cm^2 for yttrium and gadolinium borides, respectively. (auth)

28885 PROPOSED ASME PERFORMANCE TEST CODE FOR NUCLEAR REACTOR FUEL. Moore, W. T. (Babcock and

Wilcox Co., Lynchburg, Va.). J. Eng. Power, 90: 199-204(Apr. 1968).

In the process of drafting a Performance Test Code for Nuclear Reactor Fuel, a question has arisen as to whether the present state of knowledge and experience will permit the writing of a useful code at this time. A summary is given of the information currently available, and what can be accomplished by the type of code which can be written now, and recommendations are made that the code be written, incorporating information currently available for immediate use and providing a framework for the addition of further information as it becomes available. (auth)

Preparation and Fabrication

Refer also to abstracts 27957, 27960, 28771, 28772, and 30200.

28886 (BNWL-652) MECHANICAL THINNING OF CERAMIC MATERIALS FOR TRANSMISSION ELECTRON AND OPTICAL MICROSCOPY. Bauer, T. E.; Beauchamp, R. H. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Apr. 1968. Contract AT(45-1)-1830. 15p. Dep. CFSTI.

The application of the high resolving power of the transmission electron microscope to the investigation of multi-phase ceramic compounds and metal-ceramic composites is discussed. The basic problem is one of achieving sufficiently thin specimens. For good transmission electron microscopy, the specimen should be no thicker than 3000 Å (3×10^5cm). A mechanical thinning technique is described which consists of polishing one surface of a specimen, then grinding and polishing the opposite surface until the proper thickness is achieved. Specific abrasive materials are listed for each of several materials that have been thinned. Transmission electron micrographs of various materials thinned by mechanical grinding are presented. (R.C.K.)

28887 (ORNL-4204, pp 22-39) SOL-GEL PROCESS DEVELOPMENT. Haas, P. A. (Oak Ridge National Lab., Tenn.).

In the washing of precipitated uranous hydroxide, stage efficiencies of a set of mixer-decanters were as high as 89%. A 12-ft countercurrent wash column had an HTU (height of a transfer unit) of 2.3 to 3.6 ft. Dilute sols made in the P^2C^2D apparatus were successfully concentrated to desirable concentrations by continuous vacuum evaporation. The forming of satisfactory gel microspheres required a Span 80 : Ethomeen S/15 volume ratio of 4 : 1 in the 2-ethylhexanol. This concentration was maintained by continual additions of the two surfactants during operation. Fired microspheres were found to be more dense and to contain less carbon when the dried gel spheres were exposed to air overnight before firing and then further exposed to air until the temperature of the furnace reached 100°C. (auth)

28888 (RFP-882) FORMING OF CONTAINERS FOR MOLTEN NICKEL AND BERYLLIUM AT HIGH TEMPERATURES AND VACUUM. Lunde, Marvin C.; Meier, Wendelin P. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). Apr. 15, 1968. Contract AT(29-1)-1106. 13p. Dep. CFSTI.

Dense, fine-grained crucibles were made by hot pressing the powders of a variety of refractory compounds. The crucibles were tested for resistance to vacuum outgassing, to thermal shock, and to corrosion by molten beryllium and by molten nickel. Heat rates up to 900°C per minute were achieved by electron bombardment heating in vacuum of 3×10^{-5} torr. Titanium diboride was found to be a good container for molten beryllium, and a modified titanium carbide composition proved to be a satisfactory container for molten nickel. (auth)

28889 PREPARATION AND STRUCTURE OF NEPTUNIUM CARBIDES. Lorenzelli, Robert (Section d'Etudes des Ceramiques a Base de Plutonium, Fontenay-aux-Roses, France). Compt. Rend., Ser. C, 266: 900-2(Mar. 18, 1968). (In French).

The monocarbide and the sesquicarbide of neptunium were prepared. They are isomorphous with their homologs UC and PuC, on the one hand, and U_2C_3 and Pu_2C_3 on the other. The parameter of the unit cell of Np_2C_3 was determined. The dicarbide could not be prepared. (tr-auth)

28890 ACTIVATED SINTERING OF ZIRCONIUM BORIDE. Meerson, G. A.; Gorbunov, A. E. (Moscow Inst. of Steel and Alloys). Izv. Akad. Nauk SSSR, Neorg. Mater., 4: 320-4(Mar. 1968). (In Russian).

Investigation of the chemical activation of sintering processes yields the possibility of obtaining almost nonporous samples of zirconium diboride. It can be assumed that the character of the effect of the addition of zirconium dioxide and boron is the following: on ZrB_2 grain boundaries, reduction of zirconium dioxide with carbon occurs. As a result, highly active zirconium atoms are formed interacting with boron atoms and with the formation of finely divided ZrB_2, having excess energy, which accelerates the diffusion processes, starting on the particle surface and propagating throughout the whole ZrB_2 crystal. The contraction is intensified under the effects of strong surface tension. In confirmation that basically the mechanism of activated sintering is a volume-diffusion process, the circumstance that the admixture of carbon, distributed in the original boride through all the crystal volume, is completely eliminated during the activated sintering was used. (tr-auth)

28891 CERAMIC FUEL ELEMENTS WITH SPECIAL REFERENCE TO THEIR PRODUCTION BY VIBRATORY COMPACTION. Vogt, J.; Zivanovic, B.; Anastasijevic, P.; Mikijeij, V.; Ristic, M. M. (Boris Kidric Inst. of Nuclear Sciences, Belgrade). pp 737-48 of Heavy-Water Power Reactors. Vienna, International Atomic Energy Agency, 1968.

From Symposium on Heavy-Water Power Reactors, Vienna, Austria. See STI/PUB-163; CONF-670917.

A vibratory compaction technique for the production of annular and tube-in-shell fuel elements is presented. Extensive investigations showed that it is possible to achieve densities of up to 89% of theoretical using UO_2 spheres for both types of fuel elements. With fused and crushed UO_2, some lower densities (3 to 4%) were obtained. (auth)

28892 PYROLYTIC-CARBON COATINGS DEPOSITED FROM METHANE FLUID BEDS. Chin, J. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Carbon, 5: 613-17 (Dec. 1967).

Pyrolytic-carbon deposits were produced from 100% methane fluid beds at 1400 to 2000°C. The microstructures of the carbons deposited were anisotropic-columnar, isotropic, or grainy-isotropic. Formation of the anisotropic-columnar structures occurred at high methane flows, large bed areas, and low-to-intermediate temperatures. As the deposition temperatures increased, the apparent crystallite sizes increased with accompanying decreases in layer spacings, and the metallographic features of the resulting structures were those of isotropic pyrolytic carbons. Decreasing the methane flow rate and the surface area of the fluid bed at intermediate-to-high temperatures (1800–2200°C) resulted in structures which showed typical isotropic features when viewed with polarized light, but ordered grainy textures when observed with bright-field optical micrographs. The relations between deposition conditions and structure are discussed. (auth) (UK)

28893 VIBRATIONAL COMPACTING AND SWAGING AS METHODS OF PRODUCING FUEL ELEMENTS FOR NUCLEAR REACTORS. Steinkopff, H.; Schurig, Ch. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Kernenergie, 10: 357-63 (Dec. 1967). (In German).

A bibliographic review is made of the production of fuel elements by vibrational compacting and swaging. The principles and techniques of vibrational compacting and swaging as individual methods and the combined techniques are described. The radiation behavior of the fuel elements produced by the combined methods is reported with respect to structure, heat conductivity, fission-gas release, and burn-up. (J.S.R.)

28894 GRAIN GROWTH DURING HOT-PRESSING OF TANTALUM CARBIDE. Roeder, E.; Hornstra, J. (Philips Zentral-Laboratorium GmbH, Aachen. Philips' Gloeilampenfabrieken, Eindhoven, Netherlands). J. Amer. Ceram. Soc., 51: 224-5(Apr. 1968).

Observations are reported on growth kinetics during hot-pressing of TaC powder in the presence of a small quantity of the liquid grain boundary phase. A TaC compact containing 1 wt % Mn was hot-pressed for 80 min at 1800°C under 500 kg/cm^2. A photomicrograph was made from an etched section using the interference contrast method, and the various stages of growth are clearly delineated by the resulting surface relief. The mechanism of grain growth is discussed. (D.L.C.)

28895 CHARACTERISTICS OF THIN FUEL PLATES CONTAINING Al-U_3O_8 DISPERSIONS. de Souza Santos, Tharcisio D.; Haydt, Heliton M.; de Freitas, Clauer Trench; Gentile, Erberto Francisco; Cintra, Sebastiao Hermano Liete (Istituto de Energia Atomica, Sao Paulo, Brazil). Met., ABM (Ass. Brasil. Metais), 22: 935-40(Dec. 1966). (In Spanish).

The results of research related to the fabrication of thin cermet fuel plates clad with aluminum alloy are presented. The total thickness is 1.25 to 1.31 mm, with a core of a dispersion of 41.3% U_3O_8 and 58.7% Al. The blister tests and the results of x-ray and metallographic examinations of samples taken from these elements are described. The results of these tests and examinations show the homogeneity of the core composition and its perfect plastic behavior during rolling operations. The perfectly defined geometry

of the cermet in the final dimensions of the thin plates is discussed along with bonding between the cermet and its cladding. (auth)

28896 DORN METHOD IN THE STUDY OF INITIAL PHASE OF URANIUM DIOXIDE SINTERING. Bacmann, J. J.; Cizeron, G. (Centre d'Etudes Nucleaires, Grenoble, France. Centre de Recherches Metallurgiques de l'Ecole des Mines, Paris). J. Amer. Ceram. Soc., 51: 209-12(Apr. 1968).

The Dorn method, most commonly used to measure the activation energy of creep, was used to study the initial stage of sintering uranium dioxide in hydrogen from 700 to 850°C. The activation energy was approximately 100 kcal/mole. The result agrees with the value determined from analysis of isothermal shrinkage curves in the same temperature interval. (auth)

28897 URANIUM MONOCARBIDE PREPARATION IN A LIQUID METAL. Petkus, E. J.; Johnson, T. R.; Steunenberg, R. K. (Argonne National Lab., Ill.). Nucl. Appl., 4: 388-94 (June 1968).

Uranium monocarbide was synthesized on a 500- to 1000-g scale by the reaction of uranium dissolved in a liquid zinc-magnesium alloy with finely divided carbon suspended in the liquid-metal solution. The carbide precipitated as an insoluble solid phase that was heavier than the solvent metal. After a settling period, the bulk of the Zn-Mg supernatant liquid was transferred by pressure-siphoning. The Zn-Mg remaining with the UC precipitate was removed by vacuum distillation at temperatures of 850 to 900°C. The better UC products had a carbon-to-uranium atom ratio (C/U) of 1.05 to 1.10 and contained 0.2 to 0.4 wt % Mg and Zn. Uranium monocarbide was the only compound formed by this method but it was not possible to produce UC with a C/U ratio of 1.00 or less because an excess of carbon was necessary to completely react the dissolved uranium. (auth)

28898 FUEL FABRICATION IN CANADA. Stirling, W. J. (Canadian Westinghouse Co., Ltd., Hamilton, Ont.). Nucl. Eng., 13: 345-7(Apr. 1968).

The operation of the Canadian Westinghouse plant at Port Hope is described, and its flexibility is emphasized. Production processes discussed include resistance welding, induction brazing, pelletisation, together with inspection. (UK) (TSS)

28899 LARGE SCALE NUCLEAR FUEL PRODUCTION AT SPRINGFIELDS. Nucl. Eng., 13: 341-4(Apr. 1968).

Progress at the fuel production plant of the United Kingdom Atomic Energy Authority during 22 years of operation and development is reviewed. Topics discussed include organisation, management, standardisation, and developments in design and production methods. (UK)

28900 GRAPHITISATION OF POLYFURFURYL ALCOHOL. Reiswig, R. D.; Levinson, L. S.; O'Rourke, J. A. (Los Alamos Scientific Lab., N. Mex.). Carbon, 6: 124(Feb. 1968). (LA-DC-9012).

Pulverized glassy carbon with polyfurfuryl alcohol binder was cured and baked to a maximum temperature of 900°C. Following a 30 min graphitization the binder residue exhibited strong optical anisotropy. Optical and electron micrographs of etched specimens showed a lamellar structure. The lattice dimensions of the graphitized binder were obtained following pulverization and separation from the filler. (UK)

28901 HWLC GRAPHITES PREPARED BY HOT-WORKING EXTRUDED STOCK. White, J. L.; Pontelandolfo, J. M. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Carbon, 6: 1-6(Feb. 1968). (GA-7996).

Extruded graphite stock containing molybdenum metal was investigated as a starting material for the process of hot-working with a dispersed liquid carbide (the HWLC process). The extruded stock is easily deformed in compression along the extrusion axis with little risk of fracture providing that the hot-working stresses are kept below 3000 psi until the isotropic state is passed. Measurements were made of chemical composition, density, compressive and flexural strengths, thermal and electrical conductivities, and thermal expansivity for a series of HWLC–Mo materials hot-worked to various strain levels up to 65% true strain. These properties indicate that a wide range of preferred orientations is attainable, the isotropic state for the extruded material used being attained at a strain level of 20%. The properties of the HWLC–Mo graphites strained only to the isotropic state show only modest improvements over the properties of conventional graphites. At higher levels of hot-working strain the characteristic dense, uniform microstructure of the HWLC graphites is imposed on the extruded stock. The properties of material prepared from extruded stock thus approach those of materials prepared from molded stock provided that the extruded stock is hot-worked to a sufficiently higher strain level. (auth) (UK)

28902 METHODS OF PRODUCING ISOTROPIC SHAPED CARBON BODIES. (to Siemens Planiawerke Aktiengesellschaft Fur Kohlefabrikate). British Patent 1,105,764. Mar. 13, 1968. Priority date Feb. 17, 1965, Germany.

Shaped isotropic carbon bodies are produced by filling graphite molds with a green mixture of anthracite tar-pitch coke, graphite, soot, and a finely divided ground hard pitch binder. The mixture is heated to approximately 200°C to remove volatiles, and carbonized at about 1000°C for 70 hours. (P.G.C.)

28903 APPARATUS FOR CONTINUOUS CASTING OF REFRACTORY METALLIC MATERIALS. Blum, Pierre; Devillard, Jacques (to Commissariat a l'Energie Atomique). British Patent 1,108,930. Apr. 10, 1968. Priority date June 3, 1965, France.

Apparatus for continuous casting of refractory metallic materials such as UC, comprises an electron gun mounted axially above the crucible, a device for supplying the material to be melted, rotatable members for continuously replacing the crucible side wall by an identical wall, and means for rotating the complete crucible assembly to ensure better particle distribution at the surface of the melt. (P.G.C.)

28904 DENSE SPHERICAL PARTICLES. (to W. R. Grace and Co.). British Patent 1,110,253. Apr. 18, 1968. Priority date May 5, 1964, United States.

Dense microspheres of actinide oxides, or actinide oxides in combination with other oxides and/or C, for nuclear fuels, are prepared by injecting aquasol droplets of the oxides into a column of a countercurrently flowing liquid medium such as hexanol, to extract water from the aquasol and solidify the spheres. The dehydrated spheres are collected and removed from the bottom of the column. (P.G.C.)

28905 IMPROVEMENTS RELATING TO RADIATION SHIELDS. Vogel, Reinhard Ernst (to Friedrich Marxen and Reinhard Ernst Vogel). British Patent 1,110,181. Apr. 18, 1968. Filed Aug. 10, 1966.

Dispersions of a wide variety of metallic compounds are incorporated into hydraulic, non-hydraulic, or lime binders to produce building materials effective as shielding against radioactive rays. Specifically, additives as baryte, magnetite, hematite, Pb, Cd, Li, or Ba compounds of stearic or montan acids and/or other saturated fatty acids are mixed with concrete, magnesia cement, asbestos cement, or gypsum to form plasters as shielding against gamma and neutron radiation. Incorporation is also effected by acid casein, synthetic resins, or unsaturated, polymerizable polyesters. (P.G.C.)

28906 MOUNTING MEMBER FOR VIBRATORY DEVICE AND EXTRUSION APPARATUS INCORPORATING THE SAME. Jones, James Byron; Tarpley, William B. (to Aeroprojects Inc.). British Patent 1,105,566. Mar. 6, 1968. Filed Apr. 28, 1965.

An extrusion apparatus, utilizing ultrasonic effects to form ceramic like materials, incorporates a conventional cylinder, ram, and die, with a device for applying vibratory energy at a frequency of 20,000 cps, and a special conical tubular mounting member which is designed to minimize undesirable effects such as damping and frequency shifts. The hollow mounting member has a definite frequency of vibration and an acoustical length equal to an even integral number of quarter wave lengths of sound at the frequency of operation. The apparatus increases rate of extrusion and permits extrusion of materials that are non-extrudable by ordinary processes. (P.G.C.)

28907 NUCLEAR FUEL PARTICLES. (to United States Atomic Energy Commission). British Patent 1,109,621. Apr. 10, 1968. Priority date Mar. 8, 1965, United States.

Spherical, hollow, ceramic refractory UO_2 particles for nuclear fuels are produced by oxidizing UO_2 powders at 180 to 300°C, mixing with a small amount of $CaO-TiO_2$ powder, granulating the mixture, spheroidizing in an oxyacetylene flame at about 3000°C, cooling the spheroids, and reducing in H_2 at a high temperature. The spheroidized particles are characterized by high density and closed internal porosity. (P.G.C.)

28908 PROCESS FOR EXTRUDING GREEN GRAPHITE. Jones, James Byron; Tarpley, William Beverly (to Aeroprojects Inc.). British Patent 1,105,567. Mar. 6, 1968. Filed Apr. 28, 1965.

Application of ultrasonic vibration during extrusion of green graphite mixtures increased rate of extrusion, lowered the pressure required, and produced articles of superior quality. (P.G.C.)

28909 CERAMIC PROCESSING. Publication 1576, National Academy of Sciences. Washington, D. C., National Academy of Sciences, 1968. 310p.

The work of five study committee panels on methods of obtaining reliable high-integrity ceramic materials with the characteristics required for use in structures and, to a degree, electrical and electronic applications is summarized. Reports from the panels on ceramic, solids, and fluid processing, and ceramic finishing and evaluation are presented. (R.C.K.)

28910 BORON-CONTAINING MATERIALS. Rich, John; Arthur, George (to National Research Development Corp.). British Patent 1,106,291. Mar. 13, 1968. Filed Nov. 25, 1963.

Particles of B, or a B containing compound, as B4C, are given improved mechanical properties, for use in nuclear reactor control elements, by coating with an inner layer of SiC and an outer layer of TiC by a fluidized bed process. The coated particles are then incorporated in a metal matrix by cold pressing and sintering at 1300 to 1800°C, followed by hot pressing, swaging, rolling, or extrusion. A second application for the metal is in cutting and drilling tools. (P.G.C.)

28911 IMPROVEMENTS IN OR RELATING TO RADIAL EXTRUSION DIES. Richards, John Dent; Wolley, Herbert William George (to United Kingdom Atomic Energy Authority). British Patent 1,106,992. Mar. 20, 1968. Filed June 23, 1964.

The apparatus is designed to extrude metal fuel element cans, with external cooling fins, for nuclear reactors. Heated segmental dies are used in conjunction with a stepped or tapered mandrel, for applying the extruding force, means for disengaging the die segments after extrusion, and a device for sliding out the extruded can. (P.G.C.)

28912 IMPROVEMENTS IN OR RELATING TO PROCESSES FOR THE PREPARATION OF SPHERICAL PARTICLES OF NUCLEAR FUEL. van der Plas, Theo; Hermans, Marie Egidius Antonius; Noothout, Arend Jansan (to United Kingdom Atomic Energy Authority). British Patent 1,107,385. Mar. 27, 1968. Filed Aug. 29, 1964.

Spherical particles of Th and/or U with C are prepared by a sol/gel process in which the C in the form of finely divided carbon black is intimately mixed with the metal nitrate or hydroxide before peptization. The sol so produced is dispersed as droplets in a high density liquid containing a surface active agent which causes gelation. After washing and drying the particles may be heated to about 1400 to 1800°C to form nuclear carbide fuels. The method entrains all the C present in the precipitate unlike other methods in which the gelled particles may be deficient in C. (P.G.C.)

28913 MAGNETIC FORMING APPARATUS AND METHOD FOR MAKING GROOVES IN PARTS MADE OF DEFORMABLE SHEET OR SHEET-LIKE MATERIALS, PARTICULARLY TUBES MADE OF METAL OR CERAMIC-METAL MATERIALS. Veaux, Michel; Marchal, Francois (to European Atomic Energy Community). British Patent 1,101,108,001. Mar. 27, 1968. Priority date Mar. 26, 1964, Belgium.

Magnetic pulses are used to form grooves in parts made of deformable and usually electrically conducting material, as most metals and metal oxide composites such as SAP, for the purpose of joining parts together. The method is applicable to fabrication of fuel rod sheaths for reactors by joining the sheath and end closing plugs, or to form end expansion bellows in the sheath. (P.G.C.)

28914 METHOD OF PRODUCING DENSE, SINTERED BODIES OF UO_2 OR UO_2-PuO_2 MIXTURES. Russell, Lewis Eric; Harrison, John David Lawrence; Brett, Norman Harry (to United Kingdom Atomic Energy Authority). U. S. Patent 3,375,306. Jan. 11, 1965. Priority date Apr. 29, 1960, Great Britain.

A method of producing dense sintered bodies of UO_2 or a UO_2 and PuO_2 mixture is given. A compact is made by pressing powder. The compact is heated at 1300 to 1600°C in a sintering atmosphere of either Cl_2 or CO_2 and CO, and cooled in a reducing atmosphere. The cooling atmosphere for UO_2 is dry hydrogen, wet hydrogen or a mixture of CO_2 and CO. For a mixture of UO_2 and PuO_2 the reducing atmosphere is wet steam or CO_2 and CO mixture. A sintered body having a ratio of O_2 to metal atoms from 1.98:1 to 2.02:1 and a density in excess of 95% of the theoretical density is obtained. (J.C.W.)

28915 PREPARATION OF MICROSPHERES. (to W. R. Grace and Co.). British Patent 1,106,332. Mar. 13, 1968. Priority date Apr. 2, 1964, United States.

Uniform dense spheres of actinide carbides of uniform structure free from surface irregularities are produced by dispersion of sols of oxide and carbon mixtures in a nonboiling liquid medium. The liquid of the sol, usually an aquasol has a low solubility and is extracted from the droplets of the mixture by the liquid medium and they are thus solidified to spherical particles. The particles are collected, dried, and fired at 1600 to 1635°C under Ar. (P.G.C.)

Properties Evaluations

Refer also to abstracts 27729 and 29540.

28916 (WANL-TME-1549) THERMOCOUPLE INSULATOR DEVELOPMENT DURING CONTRACT YEAR 1966. Seidel, J. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). Oct. 20, 1966. 32p. Dep. CFSTI.

Three commercial BeO insulators showed a wide variation in resistance loss when evaluated at 2000°R in a system simulating current thermocouple design. The composition of the sheath material also had an effect on the system resistance. The resistance losses were explained in terms of conductance contributors. Some contributors are inherent to insulator composition and properties, and others result from the system design combined with the specific compositions of the insulator and the sheath used in the system. Conductance due to bulk carbon contamination was found to be an exception rather than a rule and was restricted to one porous insulator. Surface conductance which temporarily degraded the resistance was due to adsorbed water. Permanent degradation of the resistance was due to the system design. Products of vaporization in a tight and sealed system have no avenue of escape, they condense and deposit conductive layers at the terminals of the insulator segments and shunt the thermoelements. A possible contributor to permanent surface conductance is MgO which is usually added as a sintering aid to the BeO during fabrication. (auth)

28917 INVESTIGATION OF THE EVAPORATION OF NIOBIUM CARBIDE WITH EXPOSED SURFACE IN VACUUM. Vlasov, V. K.; Golubtsov, I. V. (Moscow State Univ.). Zh. Fiz. Khim., 42: 620-3(Mar. 1968). (In Russian).

Evaporation of niobium monocarbide in the range of homogeneity was investigated by the compound sample method using the radioisotopes ^{95}Nb and ^{14}C in the PAR-2 installation. The investigation was carried out at 2773 to 2973°K and vacuum of at least 1×10^{-6} torr. Measurement of the evaporation velocity of niobium and carbon from niobium carbide showed that the composition of the condensed phase tends to the congruently evaporated state. The time for the achievement of the congruently evaporated state in all the sample cross section of the original composition depends on the diffusion velocity of the carbon in the niobium carbide. On the basis of kinetic measurement of the evaporation velocity of niobium and carbon free the niobium carbide by two methods, the approximate values of the diffusion coefficient of carbon in niobium carbide were calculated and the activation energy for the process was evaluated as Q = 75.6 kcal/g-atom. On the basis of the experimental data an equation was proposed for the evaporation velocity of the congruently evaporated state of niobium carbide with exposed surface in a vacuum. (tr-auth)

28918 METHODS FOR THE MEASUREMENT OF THE VELOCITY OF EVAPORATION OF REFRACTORY CARBIDES WITH EXPOSED SURFACE IN VACUUM. Vlasov, V. K.; Golubtsov, I. V.; Nesmeyanov, An. N. (Moscow State Univ.). Zh. Fiz. Khim., 42: 802-5(Mar. 1968). (In Russian).

Some possible sources of error, arising during the study of evaporation of refractory materials above 2000°C, were examined. The dependence of the composition of the residual gases on the temperature for carbides of Nb and Ta was investigated in the interval from 1200 to 2700°C on the PAR-2 installation using the omegatron mass spectrometer. Diagrams of the change in the partial pressure of hydrogen, water, and N_2 + CO in the system with continuous evacuation indicated that at total pressure of the residual gases of $\sim 8 \times 10^{-7}$ torr marked interaction of heated carbide samples with water vapor beginning at ~2100°C was observed. (tr-auth)

28919 STUDY OF SUSPENSIONS OF CARBON BLACKS IN SOLS OF THORIUM OXIDE. Donnet, Jean-Baptiste; Lahaye, Jacques; Giboz, Jean-Pierre (Laboratoire de Chimie Physique, Mulhouse, France). Compt. Rend., Ser. C, 266: 860-2(Mar. 18, 1968). (In French).

The forces of interaction between the particles of carbon black and sols of thorium oxide make it possible to obtain stable suspensions of carbon black in sols of thorium oxide. Always, under the experimental conditions described, these forces do not appear to be sufficiently large to destroy the particles of carbon black and to liberate elementary crystals from it. (tr-auth)

28920 TEMPERATURE AND CONCENTRATION DEPENDENCE OF THE THERMODYNAMIC FUNCTION OF THE CARBIDE PHASE OF NIOBIUM AND TANTALUM. Nikol'skaya, T. A.; Avarbe, R. G.; Vil'k, Yu. N. (State Inst. of Applied Chemistry, Leningrad). Zh. Fiz. Khim., 42: 637-40(Mar. 1968). (In Russian).

Evaporation with exposed surface in vacuum of the carbide phases of Nb and Ta was investigated in a wide composition and

temperature (2500 to 3400°K) interval. On the basis of the data obtained on the temperature dependence and velocity of evaporation of the congruently evaporating composition of the NbC_x and TaC_x phases and the simplest model of the solid solution, temperature and concentration dependences were proposed for the component activity and the thermodynamic formation potentials in the niobium monocarbide and tantalum polycarbide phases. (tr-auth)

28921 AVERAGING TECHNIQUES IN POLYCRYSTALLINE GRAPHITES. Slagle, O. D. (Battelle Memorial Inst., Richland, Wash.). Contract AT(45-1)-1830. Carbon, 6: 111-21 (Feb. 1968). (BNWL-SA-1237(Rev.)).

The one-dimensional constant stress and constant strain models are used to calculate Young's moduli and coefficients of thermal expansion as a function of crystallite orientation in polycrystalline graphite. A previously proposed c-axis accommodation mechanism is introduced to approximate the microcracking occurring during cool-down from the graphitisation temperature. The constant stress model with accommodation is found to give the best agreement with the experimental values, but is shown to be inconsistent when porosity or a c-axis accommodation mechanism is considered. Two modified models are introduced which represent amalgamations of the one-dimensional constant stress and constant strain models. These modified models are shown to give good agreement with experiment and, in addition, give an insight into the anomalous behavior of polycrystalline graphite. (auth) (UK)

28922 COMMENTS ON THE PAPER 'THE DIELECTRIC CONSTANT OF ZIRCONIA.' Cox, B. (Atomic Energy of Canada Ltd., Chalk River, Ont.). J. Phys. D, 1: 671(May 1968).

It is pointed out that for practical applications it is the effective rather than the intrinsic dielectric constant of zirconia which is important. Possible reasons why the effective dielectric constant might be very different from the intrinsic value are discussed, and the previously published values for the dielectric constant are reinterpreted in terms of the method of measurement used and its effect on the results obtained. (auth) (UK)

28923 GASEOUS FLOW THROUGH SINTERED BERYLLIA. Clare, T. E. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). J. Aust. Ceram. Soc., 2: 24-31 (Nov. 1966).

The processes of gaseous flow through porous media are briefly described. Results from the permeation of radioactive krypton through cold-pressed and sintered beryllia show that permeability coefficients are lower than those previously published for hot-pressed beryllia and that the gaseous flow processes in the two materials are significantly different. A negligible gaseous flow (K less than 10^{-14} cm^2/sec) through cold-pressed and sintered beryllia is predicted when the beryllia is sintered for long times or at high temperatures, to a density above 96% of theoretical and an open porosity of less than 0.9%. (auth)

28924 OXYGEN DIFFUSION IN ALPHA-NIOBIUM PENTOXIDE. Sheasby, J. S. (Univ. of Western Ontario, London); Cox, B. J. Less-Common Metals, 15: 129-35(June 1968).

The diffusion of ^{18}O into single crystals of α-Nb_2O_5, in stoichiometric and nonstoichiometric condition, has been determined by the $^{18}O(p,n)^{18}F$ reaction, followed by autoradiography to determine the location of the ^{18}F. The results show that the diffusion coefficients for oxygen are up to 200 times greater parallel to [010] than perpendicular to this direction. Little difference was observed between stoichiometric and non-stoichiometric crystals. These phenomena can be explained by reference to the published structure of α-Nb_2O_5. (auth)

28925 SINTERING KINETICS OF ULTRA-FINE CALCIA STABILIZED ZIRCONIA. Wirth, David Griffith Jr. Urbana, Ill., Univ. of Illinois, 1967. 104p.

Thesis.

Kinetics for the initial, intermediate, and final stages of sintering of ultra-fine calcia stabilized zirconia were determined. Initial stage kinetics as determined by isothermal shrinkage measurements indicated a grain boundary mechanism of material transport was operative. The activation energy for sintering in this stage agreed quite closely with that for oxygen ion diffusion indicating that this species was rate controlling. This indicated that overall cation diffusion was enhanced. The results of intermediate stage kinetics as determined by isothermal porosity determination also indicated that oxygen ion was still the rate controlling diffusing species. The material transport mechanism was postulated to still be grain boundary diffusion based on the high grain boundary volume to bulk volume ratio as indicated by the small crystallite size and high activation energy for crystallite growth. Final stage kinetics as determined by isothermal grain growth studies indicated that rate control had been transferred to the cation species in the bulk. This was based on agreement between the activation energy obtained for sintering and that for cation bulk diffusion. (Disser. Abstr.)

28926 ON THE METALLOGRAPHY OF OXIDE-METAL MATERIALS. Ihrenberger, Albin; Benesovsky, Friedrich (Metallwerk Plansee AG, Reutte, Ger.). Prakt. Metallog., 4: 489-91(Sept. 1967). (In German and English).

The utilization of a mixture of refractory oxides and high melting point metals was investigated. A specimen of molybdenum–ZrO_2 mixture was embedded in plastic, dry polished on papers 400, 500, 600, and Buehler Emery 4/0, and finish polished with 1 μm-diamond board. After etching, the two phases are shown. The weldability of these materials was investigated and the welding failures discussed. (J.C.W.)

28927 METHODS OF CHEMICAL ETCHING FOR CERAMIC MATERIALS. Politis, Constantin (Nuclear Research Centre, Karlsruhe, Ger.); Ohtani, Shitoshi. Prakt. Metallog., 4: 401-16 (Aug. 1967). (In German and English).

The structure of unetched uranium mononitride cooled slowly from the melt may be observed. The grain boundaries have been made visible because precipitated uranium has evaporated onto them during the heat treatment and it is usually necessary to reveal the structure of ceramic materials by some method. Chemical reagent use is discussed and data given, as metallic materials etching is dependent on the condition of the polished surface. Illustrated are the structures of oxides with strong acids. Etching reagents and conditions for simple oxides, mixed oxides, and non-oxidic materials are tabulated. In the case of non-oxidic ceramic materials, etching in vapor is necessary sometimes. The polished specimen is suspended in a closed vessel in which the etching reagent is boiled. If ceramic and metallic materials are combined, etching becomes difficult. The varying attack on the phases by the etchant often necessitates combined etching sequences. Etchant compositions for carbide and nitride cermets are tabulated. (J.C.W.)

28928 ELASTICITY AND ANELASTICITY OF URANIUM OXIDES AT ROOM TEMPERATURE. II. HYPERSTOICHIOMETRIC OXIDES. Forlano, Roberto J.; Allen, A. W.; Beals, R. J. (Univ. of Illinois, Urbana. Argonne National Lab., Ill.). Contract W-31-109-Eng-38. J. Amer. Ceram. Soc., 51: 192-5(Apr. 1968).

The Young's modulus and internal friction of hyperstoichiometric uranium dioxide at room temperature were determined by a sonic technique. Young's modulus decreased, whereas internal friction increased, with increasing O/U ratios. These effects are attributed to the precipitation of U_4O_9. A complete microstructural characterization is needed. (auth)

28929 HEMISPHERICAL SPECTRAL EMITTANCE OF SELECTED RARE EARTH OXIDES. McMahon, W. R.; Wilder, D. R. (Ames Lab., Iowa). J. Amer. Ceram. Soc., 51: 187-92(Apr. 1968).

The hemispherical spectral emittances for the sesquioxides of yttrium, samarium, gadolinium, erbium, thulium, and ytterbium are given for five wavelengths in the visible portion of the spectrum at 1400 to 3000°K. A reflectance technique incorporating a carbon arc image furnace and a standard of reflectance was used in the determinations. The emittance of zirconium dioxide was measured to check the validity of the method. (auth)

28930 LINEAR THERMAL EXPANSION OF THREE TUNGSTATES. Martinek, Charles; Hummel, F. A. (Pennsylvania State Univ., University Park). J. Amer. Ceram. Soc., 51: 227-8(Apr. 1968).

Experimental thermal expansion data are presented for ZrW_2O_8, $Al_4W_3O_{21}$, and Cr_2WO_6 at temperatures up to 975°C. Cr_2WO_6 had an appreciable positive coefficient, while $Al_4W_3O_{21}$ had a low positive coefficient, and that of ZrW_2O_8 was negative. The results are in agreement with literature values and predictions. (D.L.C.)

28931 TEMPERATURE DEPENDENCE OF THE ELASTIC MODULI OF $91Y_2O_3 + 9ThO_2$ FROM 25° TO 1100°C. Dickson, R. W. (National Bureau of Standards, Washington, D. C.); Anderson, R. C. J. Amer. Ceram. Soc., 51: 233-4(Apr. 1968).

Data from 25 to 1087°C are given for the Young's modulus, shear modulus, and Poisson's ratio for a solid solution of sintered 91.03 Y_2O_3–8.97 ThO_2. The anion interstitial model was used to calculate the theoretical density and porosity. Correction for the porosity indicates that the moduli do not obey the linear rule of mixtures. (D.L.C.)

28932 TEMPERATURE COEFFICIENT OF THE ELECTRIC RESISTANCE OF SOME REFRACTORY COMPOUNDS. Samsonov, G. V.; Grebenkina, V. G. (Inst. of Problems in Material Studies, Kiev). Porosh. Met., Akad. Nauk Ukr. SSR, No. 2, 35-40(Feb. 1968). (In Russian).

The temperature dependence of the electric resistance is inves-

tigated in the range of temperatures up to 1000°C of carbides, borides, nitrides, and silicides of the transition metals prepared by the methods of powder metallurgy. The results obtained are discussed from the point of view of the stable electronic configurations. The metals whose compounds were studied are: Ti, Zr, V, Nb, Ta, Mo, and W. (auth)

28933 ELASTIC PROPERTIES OF ISOTROPIC GRAPHITE. Cost, J. R. (Purdue Univ., Lafayette, Ind.); Janowski, K. R.; Rossi, R. C. Phil. Mag., 17: 851-4(Apr. 1968).

Young's modulus and the shear modulus (at room temperature) are reported for the first time for bulk isotropic graphites of various porosities. Extrapolations to zero porosity indicate Young's modulus and the shear modulus of theoretically dense isotropic graphite to be 255 kilobars and 97 kilobars, respectively. Poisson's ratio for fully dense isotropic graphite was found to be 0.31 compared with previous literature values of 0.14 and less. (auth) (UK)

28934 STUDY OF THERMAL CONDUCTIVITY OF MIXED OXIDES OF U AND Pu. Van Craeynest, J. C.; Weilbacher, J. C. (CEN, Fontenay-aux-Roses, France). J. Nucl. Mater., 26: 132-6(Apr. 1968). (In French).

Thermal conductivity of nuclear fuels composed of mixed oxides of U and Pu was measured as a function of the relationship of O to metal at 100 to 2000°C. Density of specimens used in the measurements was 95% of theoretical. Variations in thermal diffusivity, as a function of temperature, were found to be most important between 50 and 1000°C for compositions near $(U-Pu)O_{2.00}$. (P.G.C.)

28935 COMMENTS ON A PAPER BY E. PATRASSI, (THE THERMAL CONDUCTIVITY OF UO_2 AT VERY HIGH TEMPERATURE GRADIENTS). Fulkerson, W.; McElroy, D. L.; Moore, J. P. (Oak Ridge National Lab., Tenn). J. Nucl. Mater., 26: 223-6(1968).

Data on UO_2 obtained in the ORNL radial-heat-flow apparatus at 436°C are recorded verifying previous data indicating that large temperature gradients yield a measured thermal conductivity less than for small gradients because of thermal stresses. Longitudinal heat-flow thermal conductivity values for single-crystal UO_2 at 100°C for various compressive stresses and temperature gradients on the specimen are tabulated. (J.C.W.)

28936 CORRELATION BETWEEN ACTIVATION ENERGIES FOR STEADY-STATE CREEP AND SELF-DIFFUSION IN BERYLLIUM OXIDE. Seltzer, M. S. (Battelle Mmeorial Inst., Columbus, Ohio). J. Nucl. Mater., 26: 232-4(1968).

Experiments have been performed on single crystals and polycrystals of BeO in atmospheres of air, argon, vacuum, or oxygen and on crystals whose impurity content varied. The results are tabulated. Results show that activation energies for creep in beryllium oxides cannot be correlated with either the activation energy for self-diffusion of beryllium or oxygen. Diffusion energy which approaches that for creep is the value of 4.0 eV for self-diffusion of beryllium found at temperatures below 1725°C. (J.C.W.)

28937 THE HIGH-TEMPERATURE CREEP BEHAVIOR OF A HIGHLY ORIENTED POLYCRYSTALLINE GRAPHITE. Zukas, E. G.; Green, W. V. (Los Alamos Scientific Lab., N. Mex.). Carbon, 6: 101-10(Feb. 1968).

The creep behavior of a heavily oriented graphite was studied extensively to determine the influence of the crystallographic orientation on creep properties in an attempt to understand creep deformation in graphite. The creep rates were studied both in tension and compression as a function of Φ, the angle between the stress axis and the "average" c-direction orientation of the billet. The creep rates in tension varied from 5×10^{-3} for $\Phi = 0°$ to 5×10^{-8} min^{-1} for $\Phi = 90°$ at a stress of 2020 psi. The compression creep rates for all angles were slower than any of the tensile creep results for an equivalent stress. The instantaneous creep rate was proportional to the eighth power of stress as determined by the unispecimen technique, where the creep rates for the same sample were compared immediately before and immediately after a stress change. The activation energies were determined in a similar manner, where the comparison of the creep rates was made before and after a temperature change. The measured activation energies for tensile creep averaged 277,000 cal/mole. Neither the stress dependence nor the activation energies were influenced by orientation angle and were similar for both tension and compression creep. Recovery on release of the load was appreciable (~25% of the creep strain) and was temperature and time dependent. Optical microscopy before and after creep strain on the same areas was used to study the deformation modes. (auth) (UK)

28938 THE STORAGE BEHAVIOR OF URANIUM DIOXIDE POWDERS: REVIEW ARTICLE. Bannister, M. J. (Australian Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). J. Nucl. Mater., 26: 174-84(1968).

The storage behavior of uranium dioxide powder is reviewed. Topics covered include the amount of oxygen taken up under storage conditions, the effects of extra oxygen on the fabrication and irradiation behavior of uranium dioxide, the basic oxidation processes, the pyrophoric reaction of uranium dioxide powders in air, and the protection of uranium dioxide against oxidation. The pyrophoric process in air at room temperature is shown to be the result of rapid chemisorption of oxygen, and a theory explaining this effect is developed. The individual rate equations for the basic oxidation processes operative at room temperature are combined to give a law for the overall oxidation behavior at room temperature, and comparisons are made with previous data. (auth)

28939 THEORY OF THE EFFECT OF CRYSTALLITE BOUNDARIES ON THE PRINCIPAL THERMAL CONDUCTIVITIES OF HIGHLY ORIENTED GRAPHITE. Kelly, B. T. (United Kingdom Atomic Energy Authority, Culcheth, Eng.). Carbon, 6: 71-80 (Feb. 1968). (TRG-Report-1497).

A theory of the principal conductivities of highly oriented graphite as limited by crystal boundaries parallel and perpendicular to the hexagonal axis is derived. The lattice dynamics of the graphite crystal are assumed to be those of the semi-continuum model due to Komatsu. In the direction parallel to the layer planes each of the three acoustic vibrational modes contributes roughly the same amount to the conductivity. The crystallite boundaries parallel to the hexagonal axis, defining a scattering length L_a parallel to the basal planes, essentially control the conductivity in this direction. In the direction parallel to the hexagonal axis a major contribution to the conductivity comes from the acoustic mode in which the atomic vibrations are polarized parallel to the hexagonal axis. The principal conductivity is affected by both types of crystal boundary, the boundaries parallel to the hexagonal axis being more important at high temperatures while those parallel to the basal planes are most important at low temperatures. The theoretical results are briefly compared with the available experimental data on the principal conductivities of highly oriented pyrolytic graphite. (auth) (UK)

28940 USE OF MOLYBDENUM IN TiC-BASED CERMETS. Fairhurst, W. (Climax Molybdenum Co., New York). Metallurgia, 77: 145-9(Apr. 1968).

One of the problems in using TiC-base cermets has been that of obtaining an aggregate with a fine grain size capable of withstanding the loads involved in cutting and similar applications. Molybdenum is now almost universally used in the binder or the carbide phase, and in the former case it causes complete wetting of the TiC and results in a fine particle size with a continuous film of binder round each grain. Small additions of molybdenum carbide have a strengthening effect that appears comparable to that of molybdenum additions to the binder. The presence of high amounts of molybdenum in the binder can lead to valuable lubricating characteristics at higher service temperatures. (auth) (UK)

Structure and Phase Studies

Refer also to abstracts 27707, 27729, 27730, 28745, 28820, and 30386.

28941 (AAEC/E-188) ATOMIC DIFFUSION IN CERAMIC OXIDES. de Bruin, H. J.; Bradhurst, D. H.; Walker, D. G. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Dec. 1967. 39p. (CONF-670837-1). Dep.

From Symposium on Properties of Materials at High Temperatures, Sydney, Australia.

Diffusion mechanisms in ceramic oxides are considered and available data in the literature broadly reviewed. It is noted that a simple correlation for cation self-diffusion in oxides based on structural considerations is not likely to eventuate, although some correlation for oxygen diffusion should exist. Greater sensitivity is required to study diffusion in oxides that can be obtained by conventional tracer lapping. The less common methods that may be applicable are reviewed. (73 references). (auth)

28942 (PEL-165) PROBLEM OF BONDING IN THE URANIUM NITRIDES. Segal, N.; Sebba, F. (Atomic Energy Board, Pelindaba, Pretoria (South Africa)). Dec. 1967. 16p. Dep.

Phase relationships, general properties, and the electronic structure of uranium nitrides are discussed, including theory of bonding in the refractory hard metals and the classification of uranium nitrides and carbides as refractory hard metals. (96 references). (P.C.H.)

28943 THERMODYNAMICS OF THE TRI-COMPONENT PHASE OF INTRODUCTION. Andrievskii, R. A. Zh. Fiz. Khim., 42: 603-8(Mar. 1968). (In Russian).

Formulas for the partial free energy and configuration entropy of the three-component phases of different types were obtained. The possibility of using these expressions in connection with data on surplus entropy and heat of mixing was examined. The phases studied were those consisting of two metals and one metalloid (solutions of the type Ta_2C-V_2C, HfN–TiN, and TiH_2-ZrH_2), phases consisting of one metal and two metalloids in one sublattice (NbC–NbN, TiC–TiO), and phases in which two metalloids are distributed in two sublattices, octahedral and tetrahedral (TiN–TiH_2 and ZrC–ZrH_2). (tr-auth)

28944 STRUCTURE AND PROPERTIES OF TWO NEW COMPOUNDS IN THE SYSTEM Nb_2O_5–MgO. Tilloca, Gilbert; Perez y Jorba, Monique (CNRS, Vitry-sur-Seine, France). Compt. Rend., Ser. C, 266: 906-7(Mar. 18, 1968). (In French).

Four intermediate compounds exist in the system Nb_2O_5-MgO. The first, $Mg_xNb_{1(x/4)}O_{2\beta}$, shows an orthorhombic–monoclinic transformation at 1400°C, and the others are $MgNb_2O_6$, $Mg_5Nb_4O_{15}$, and $Mg_4Nb_2O_9$. The equilibrium diagram was established. (tr-auth)

28945 CRYSTAL STRUCTURES OF LaC_2. Bowman, A. L.; Kirkorian, N. H.; Arnold, G. P.; Wallace, T. C.; Nereson, N. G. (Univ. of California, Los Alamos, N. M.). Acta Crystallogr., Sect. B, 24: 459-60(1968). (LA-DC-7423).

Lanthanum dicarbide was examined by high-temperature neutron diffraction. A tetragonal to cubic transformation was observed at 1060°C, with lattice parameters $a_0 = 4.00$, $c_0 = 6.58$ Å at 900°C and $a_0 = 6.02$ Å at 1150°. The structure of the tetragonal phase was found to be the C11a calcium carbide-type, in agreement with previous room temperature results. The structure of the cubic phase is the KCN type. Both phases are isomorphous with the corresponding uranium dicarbide phases. (auth) (Denmark)

28946 INVESTIGATION OF THE SYSTEM HfO_2–Sm_2O_3 IN THE SOLID PHASE IN THE REGION RICH IN HAFNIUM DIOXIDE. Isupova, E. N.; Glushkova, V. B.; Keler, E. K. (Inst. of Chemistry of Silicates, Leningrad). Izv. Akad. Nauk SSSR, Neorg. Mater., 4: 399-405(Mar. 1968). (In Russian).

The structure diagram of $HfO_2-Sm_2O_3$ in the solid phase was constructed in the region rich in HfO_2. A comparison was made between the diagrams of $HfO_2-Sm_2O_3$ and $ZrO_2-Sm_2O_3$. During the interaction of HfO_2 with Sm_2O_3 as a primary product of the reaction, solid solutions are formed with a composition close to 33 mol.% Sm_2O_3 + 67 mol.% HfO_2, which, reacting further with excess HfO_2, forms equilibrium reaction products. The effect of small additions of samarium oxide on the monoclinic-tetragonal conversion of HfO_2 was studied. (tr-auth)

28947 EQUIVALENCE OF X-RAY AND ELECTRON MICROSCOPY CRYSTALLITE SIZES IN THORIA GEL. Bannister, M. J. (Australian Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). J. Amer. Ceram. Soc., 51: 228-9(Apr. 1968).

ThO_2 gel was crushed and different samples were sintered at 600 to 900°C. Crystallite sizes were measured in the partially sintered specimens by x-ray diffraction and electron microscopy. The results are compared on the basis of the equivalent crystallite size calculated from the experimental x-ray diffraction line profiles; the size range was from 64 to 400 Å. The results are very close to the linear exact-equality line. (D.L.C.)

28948 PHASE EQUILIBRIA IN THE SYSTEMS OF W–Cr–B AND W–Mo–B. Telegus, W. S.; Kuz'ma, Yu. B. (L'vov Order Lenin State Univ.). Porosh. Met., Akad. Nauk Ukr. SSR, No. 2, 68-75(Feb. 1968). (In Russian).

The systems of W–Cr–B and W–Mo–B were investigated by means of x-ray diffraction analysis. The phase equilibria are established in the system of W–Cr–B at 1500 and 800°C and in the system of W–Mo–B at 1500°C. In the system of W–Cr–B the ternary compound $W_{3.2}Cr_{1.8}B_3$ exists in the solid state and has a crystal structure of Cr_2B_3 type (a = 5.699 ± 0.003 Å, c = 10.88 ± 0.01 Å, c/a = 1.91). The compound of W_2B dissolves 61 at. % of Cr, the compound of CrB–37 at. % of W. The continuous solid solution W_2B-Mo_2B exists in the system of W–Mo–B. (auth)

28949 STATE DIAGRAM OF RHENIUM–BORON SYSTEM. Portnoi, K. I.; Romashov, V. M. Porosh. Met., Akad. Nauk Ukr. SSR, No. 2, 41-4(Feb. 1968). (In Russian).

The alloys of rhenium with boron were investigated by the methods of thermal, roentgenographic, and metallographic analyses. A state diagram of rhenium–boron system is proposed. (auth)

28950 THE PHASE EQUILIBRIA IN THE SYSTEMS OF VANADIUM–CHROMIUM–CARBON, NIOBIUM–CHROMIUM–CARBON AND TANTALUM–CHROMIUM–CARBON. Fedorov, T. F.; Popova, N. M.; Gorshkova, L. V.; Skolozdra, R. V.; Kuzma, Yu. B. (Inst. of Metallurgy, Moscow). Porosh. Met., Akad. Nauk Ukr. SSR, No. 3, 42-8(Mar. 1968). (In Russian).

The systems of V–Cr–C, Nb–Cr–C, and Ta–Cr–C were investigated by means of x-ray and microscopical analyses. The phase equilibria in the system of C–Cr–C at 1000°C were established and the compound of the approximate composition of VCr_2C_2 was also found. The solid solution of chromium in VC is 30 at. %, in V_2C–32–33 at. %. In the systems Nb–Cr–C and Ta–Cr–C, the phase quilibria were established at 1050 and 1000°C. The ternary carbides Nb_3Cr_3C were not found. (auth)

28951 PHASE DIAGRAMS OF THE SYSTEMS Cr_2O_3–TiO_2 AND Cr_2O_3–ZrO_2. Berezhnoi, A. S.; Gul'ko, N. V. (Inst. of Geological Sciences, Kiev). Dopov. Akad. Nauk Ukr. RSR, Ser. B, No. 3, 250-3(Mar. 1968). (In Russian).

On the basis of experimental data and data cited in literature, a phase diagram of the system $Cr_2O_3-TiO_2$ in which there are two eutectics (2153°K, 50 mole % of TiO_2 and 2033°K, 96 mole % of TiO_2) was formed. The phase $Cr_2Ti_2O_7$ melts congruently at 2253°K. There are two series of solid solutions at high temperatures (80 to 94 and 96 to 100 mole % of TiO_2). The density of $Cr_2Ti_2O_7$ is 4.54 g/cm³. The entropy of this composition, the heat of formation from oxides, and the heat of melting were evaluated (43 eu–2.2 kcal and 28 kcal/mol, correspondingly). The system $Cr_2O_3-ZrO_2$ is eutectic. The calculated melting point of the eutectic in it (2360°K) at 39 mole % of ZrO_2 is in accordance with the experimental data of Wartenberg. (auth)

28952 ELECTRON MICROSCOPE STUDIES OF URANIUM SULPHIDE SINGLE CRYSTALS. I. SLIP BEHAVIOUR. Sole, M. J.; Van der Walt, C. M.; Truzenberger, Maria (Atomic Energy Board, Pretoria). Acta Met., 16: 667-70(May 1968).

The slip behavior of uranium sulfide single crystals has been studied by transmission electron microscopy. It is shown that the primary slip plane is {110}, but that slip on {111} planes is also possible. Those facts suggest that the bonding in US is a mixture of ionic and covalent/metallic, with the ionic contribution greater than in UC or UN. (auth)

28953 ELECTRON MICROSCOPE STUDIES OF URANIUM SULPHIDE SINGLE CRYSTALS. II. PRECIPITATION PHENOMENA. Sole, M. J.; Van der Walt, C. M.; Truzenberger, Maria (Atomic Energy Board, Pretoria). Acta Met., 16: 671-81(May 1968). (PEL-155).

Using transmission electron microscopy three types of precipitates have been observed in single crystals of uranium sulfide grown from the melt. Two of these have been identified as uranium oxysulfide and β-uranium disulfide and orientation relationships between them and the matrix have been determined. Details of their growth mechanisms are given and an explanation for groove etching in US put forward. (auth)

28954 PRECIPITATES IN ARC-MELTED THORIA. Van der Walt, C. M.; Louw, H. N. J. (Atomic Energy Board, Pretoria). Acta Met., 16: 777-9(May 1968).

Specimens, suitable for transmission electron microscopy, were prepared from arc-melted thoria ingots by crushing the material and examining the resulting flakes. The major cleavage plane was found to be {111}, while {110} and {100} occur occasionally. Faults on {111} planes spike the reciprocal lattice in ⟨111⟩ directions and it is suggested that these are probably thin platelets of ThO which precipitated due to non-stoichiometry. (auth)

28955 A STUDY OF CATION DIFFUSION IN UO_2 AND ThO_2 USING α-RAY SPECTROMETRY. Hawkins, R. J.; Alcock, C. B. (Imperial Coll. of Science and Tech., London). J. Nucl. Mater., 26: 112-22 (Apr. 1968).

Volume diffusion coefficients have been measured for uranium self-diffusion in UO_{2+x} and for thorium in ThO_2. The concentration profiles were determined by α-ray spectrometry, using the isotopes ^{233}U and ^{230}Th. In the UO_{2+x} study the diffusion coefficients which were obtained from polycrystalline and single crystal samples were in good agreement. The volume diffusion contribution in the polycrystalline samples was separated from the significant gain boundary diffusion using an analysis due to Suzuoka. The volume diffusion coefficient increased very rapidly for $0 \leq x \leq 0.02$, the change being about two orders of magnitude at 1400°C. The self-diffusion coefficient of thorium in thoria was found to be independent of the ambient oxygen pressure within experimental error. (auth)

28956 DIFFUSION OF CARBON IN THE CARBIDES OF TANTALUM. Brizes, W. F. (Westinghouse Astronuclear Lab., Pittsburgh). J. Nucl. Mater., 26: 227-31(1968).

The diffusivities averaged over the entire compositional range of TaC are determined. Tantalum metal slabs (>99.9 wt % purity) were isothermally carburized in contact with high purity lamp-

black at 2100 to 2650°C and chemical analysis after annealing indicated only a slight increase in oxygen and nitrogen (<150 ppM total). A photomicrograph of a typical sample carburized at 2300°C is shown. Two distinct scales of TaC and Ta_2C were found. The precipitated phases observed within each of the carbide scales formed upon cooling due to changes in the carbon solubility with temperature. Isothermal anneals below 2300°C showed a third single phase layer which is formed between TaC and Ta_2C and was interpreted as being the zeta phase and its composition and x-ray diffraction data have been reported previously. The zeta layer did not noticeably affect the calculation of the diffusion coefficients since the expressions for the diffusivity for both TaC and Ta_2C are continuous into the temperature range at which the zeta phase is stable, 2200 ± 50°C. (J.C.W.)

28957 HABIT PLANES OF ZIRCONIUM HYDRIDE IN ZIRCONIUM AND ZIRCALOY. Westlake, D. G. (Argonne National Lab., Ill.). J. Nucl. Mater., 26: 208-16(1968).

The habit planes for precipitation of zirconium hydride in Zircaloy-2 and Zircaloy-4 have been determined to be $\{10\bar{1}7\}$. The standardization of experimental techniques allows a valid comparison of this result with the $\{10\bar{1}0\}$ habit plane determined earlier for pure zirconium. Discrepancies between the results and earlier investigations are discussed and explanations are proposed. (auth)

28958 HIGH TEMPERATURE DIFFRACTOMETRY OF ZrO_2-BASE MATERIALS. Filatov, S. K.; Frank-Kamenetzkij, V. A. (Univ., Leningrad). Kris. Tech., 2: 577-90(1967). (In German).

A high temperature (about 1300°C) diffractometry method for analysis of monoclinic ZrO_2-base powdered materials is described. Examples are given. Special attention is directed to the exactness of the indication of the Debye–Scherrer photographs and to the evaluation of defects by the determination of parameters using simplified methods. The limitations for high-temperature diffractometry of tetragonal and cubic ZrO_2-base materials are discussed. (tr-auth)

28959 THERMODYNAMIC STUDY OF THE URANIUM OXYCARBIDE SYSTEM. Javed, N. A. London, Imperial Coll. of Science and Tech., 1968. 206p.

Thesis.

The maximum solubility of oxygen in the UC lattice and the thermodynamic properties of the resulting U(C,O) phase were studied using both isothermal and isopiestic techniques in the temperature range 1473° to 1648°K. These techniques enabled the U(C,O) to be equilibrated with uranium activities in the range of 1 to 10^{-3}, and oxygen partial pressures of 4×10^{-26} to 4.4×10^{-35} atm. The results indicate that the maximum solubility of oxygen corresponds to the formula $U(C_{0.68},O_{0.32})$. With increasing oxygen content the lattice parameter usually decreases, and the lowest lattice parameter value is shown by the oxygen saturated UC, and is in the range 4.951 to 4.952 Å. The maximum solubility of oxygen in the UC lattice was also found to be almost independent of temperature within the range 1473°K to 1648°K. Assuming that the U(C,O) phase is a pseudobinary solid solution of UC and UO, a modified Gibbs–Duhem relationship was derived in order to calculate the activity coefficients of UC at various compositions of the pseudobinary solid solutions. The results indicate a negative deviation from Raoult's law. The activities of carbon were also calculated and employed to calculate the standard free energy of formation values of the U(C,O) phase, and the associated equilibrium partial pressures of carbon monoxide for various compositions and at different temperatures. Equilibration experiments were also carried out at 1573°K in which either UC_2 or U_2C_3 was equilibrated with UC at fixed activities of uranium and oxygen. The results indicated that UC_2 containing oxygen could be more stable than the U_2C_3 phase. U_2C_3 was not found to contain any measurable oxygen in its lattice. A tentative phase relationship for the U–C–O system at 1573°K is proposed. (auth) (UK)

Radiation Effects

Refer also to abstract 28846.

28960 (BNL-10306) STORED ENERGY RELEASE IN NEUTRON-IRRADIATED PYROLYTIC GRAPHITE. Arndt, R. A. (Brookhaven National Lab., Upton, N. Y.). [nd]. Contract AT(30-2)-Gen-16. 8p. Dep. CFSTI.

Measurements of stored energy were made on neutron irradiated pyrolitic graphite deposited at 2100°C and on the same material annealed for 2 hrs at 3000°C. It was found that stored energy release from the neutron irradiated annealed pyrolitic graphite in the region of 200°C is about ½ of that in the as-deposited graphite. (P.G.C.)

28961 ELECTRON MICROSCOPE OBSERVATION OF IRRADIATION DEFECTS IN URANIUM DIOXIDE. Bisson, A.; Frisby, H.; Hairion, J.-P. pp 41-7 of Fragilite et Effets de l'Irradiation. 10e Colloque de Metallurgie, Saclay, France. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay. Paris, Presses Universitaires de France, 1967. (In French).

From 10th Symposium on Special Metallurgy Brittleness and Irradiation Effects, Saclay, France. See CONF-660656.

Electron microscopy was used to study the neutron irradiation damage on uranium dioxide at various temperatures. Since the samples are irradiated in the form of pellets, it was necessary to develop a method of preparing thin plates, transparent to electrons. The solution adopted was to set up in a hot cell the grinding method that had given good results with other metal oxides (in particular BeO and MgO). It is shown that grinding only introduces a small number of dislocations which are moreover very localized and easily detected. In addition, this operation does not eliminate the defects produced by irradiation. The advantages of this method for the preparation of samples suitable for electron microscope examination are presented. The preliminary results of this study confirm the presence in uranium dioxide, irradiated at about 10^{18} thermal neutrons at a temperature below 400°C, of edge dislocation loops for which the Burgers vector is in a [110] direction. In addition, a powder of UO_2 crystallites of about 50 Å deposited during irradiation, is collected on the free surface of these samples. Finally the results obtained with samples irradiated at a higher temperature are presented; these show special characteristics as far as loops and microporosities are concerned. (auth)

28962 INFLUENCE OF NEUTRON IRRADIATION ON THE MECHANICAL CHARACTERISTICS OF REFRACTORY OXIDES. Elston, J.; Labbe, C.; Maillard, A. pp 217-25 of Fragilite et Effets de l'Irradiation. 10e Colloque de Metallurgie, Saclay, France. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay. Paris, Presses Universitaires de France, 1967. (In French).

From 10th Symposium on Special Metallurgy Brittleness and Irradiation Effects, Saclay, France. See CONF-660656.

After irradiation of refractory oxides at 70 to 100°C, the grains of the material show a hardening due to anchoring of the dislocations by neutron-induced point defects. This hardening leads to an improvement in the mechanical characteristics of sintered MgO and Al_2O_3. On the other hand, the mechanical characteristics of sintered BeO deteriorate under the same conditions, because of grain separation resulting from stresses produced by anisotropic expansion of the BeO lattice under irradiation. This deterioration depends not only on the dose received but also on the grain size, the density, and even the method of sample preparation. When BeO is irradiated at high temperature, 1,000°C for instance, an improvement in the mechanical characteristics is observed up to about 2×10^{21} nvt × cm^{-2}, although these deteriorate for higher doses. The influence of stresses and heat cyclings and that of the preferential precipitation of helium at the grain boundaries is discussed. The question of brittleness in irradiated silica is broached. (auth)

28963 INFLUENCE OF TEMPERATURE ON THE DEVELOPMENT OF IRRADIATION INDUCED DEFECTS IN BeO, MgO, Al_2O_3. Frisby, H.; Bisson, A. pp 85-92 of Fragilite et Effets de l'Irradiation. 10e Colloque de Metallurgie, Saclay, France. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay. Paris, Presses Universitaires de France, 1967. (In French).

From 10th Symposium on Special Metallurgy Brittleness and Irradiation Effects, Saclay, France. See CONF-660656.

The effect of out-of-pile heat treatment, on point and linear defects in sintered beryllium oxide irradiated with neutrons at temperatures below 100°C was followed by electron microscope examination. A large proportion of particles transparent to electrons and suitable for microscopic study was obtained by mere grinding. It is found that irradiations at this temperature (T_{irr} < 100°C) produce clustering of point defects in the BeO lattice. The deformation of the lattice around each cluster (producing the Bragg contrast which makes the defect visible in the electron microscope) increases with the total neutron dose received. Out-of-pile heating of the sintered pellets change the defect clusters into edge dislocation loops situated in the BeO basal planes. They result from the coalescence and reorganization of interstitials formed in the lattice by neutron bombardment. Similar examinations were carried out on irradiated magnesia and alumina. The results obtained with these three oxides are compared and discussed. (auth)

28964 ELECTRON SPIN RESONANCE IN GRADE A REACTOR GRAPHITE, NEUTRON-IRRADIATED AT 80°K. Faulkner, E. A.; Kluth, E. L. E. (Univ. of Reading, Eng.). Carbon, 5: 619-22(Dec. 1967).

Preliminary results are reported of an ESR investigation on

solid blocks of grade A reactor graphite, neutron irradiated at 80°K. In particular, a pulse annealing experiment on a specimen with neutron dose of 3×10^{17} nvt is described. On annealing to temperatures up to 300°K the integrated intensity of absorption decreased monotonically, but the half-peak derivative width displayed a reverse annealing feature between 170°K and 240°K. The peak to peak derivative height indicated annealing activity between 135°K and 170°K, the temperature range in which the Austerman peak occurs for resistivity measurements. The temperature dependence of the integrated intensity of absorption was measured for specimens annealed to 300°K. This shows that both localized spin centers and carriers contribute to the absorption and that neutron irradiation increases the relative contribution due to localized centers. (auth) (UK)

28965 ELECTRON SPIN RESONANCE IN GRAPHITE DAMAGED HEAVILY IN REACTOR. Mizushima, Sanchi (Keio Univ., Koganei, Japan). Carbon, 6: 13-17(Feb. 1968).

The change in behavior of ESR in artificial graphite on annealing was studied after an irradiation dose of 5.8×10^{20} nvt at 30°C. The temperature dependence of the absorption intensity showed that the spin centers were composed of free carriers and localized spins. As the Fermi level rose on recovery of the lattice from defects with the progress of annealing, the contribution from the free carriers decreased. After annealing at 1100°C, it coincided approximately with the absorption intensity of unirradiated graphite, for which the relevant spins are exclusively due to free carriers. The number of localized spins dropped from about 10^{20} per gm to a vanishingly small value after heat treatment at 1000°C. (UK)

28966 EFFECT OF SHORT-TERM NEUTRON IRRADIATION ON THE SHEAR COMPLIANCE OF HOT-WORKED PYROLYTIC GRAPHITE. Jenkins, G. M. (Univ. College, Swansea, Wales); Jouquet, G. Carbon, 6: 85-91(Feb. 1968).

A direct technique is described for the measurement of the shear compliance in thin specimens of various types of graphite. It involves determination of the torsional resonant frequency of compound aluminum–graphite specimens. Using this technique the shear modulus (C_{44}) of hot-worked pyrolytic graphite of density 2.23 g/ml was found to be $3.1 \pm 0.4 \times 10^9$ dynes/cm^2. The C_{44} of graphite single crystals was calculated to be $\sim 4.0 \times 10^{10}$ dynes/cm^2 from specific heat data, so that most of the observed compliance must be attributed to dislocation movement. Electron microscope studies of the graphite indicated it to be similar in structure to heavily sheared crystals of natural graphite and that probable dislocation anchorage points are micro-twins and unit c-axis dislocations. Neutron irradiations were carried out at 30°C up to doses of 5×10^{17} nvt (Ni) to reach saturation. The maximum value of C_{44} measured was 3.3×10^{10} dynes/cm^2. It is postulated that saturation at such low doses occurs not only by the complete blocking of dislocation movements, but by the interaction and combination of efficient "pinning" defects and new single interstitials to form larger less efficient defect clusters at higher doses. This combination process is also observed on annealing the irradiated specimens at temperatures up to 1000°C. The maximum rate of decrease in modulus and also, therefore, in "pinning" defect population occurs at about 200°C. Possible configurations of these pinning defects are discussed in the light of these results. It was concluded that primary bonds exist between small interstitial clusters and the original basal planes. Conclusions are made with regard to reactor-grade graphites, it being demonstrated that in this case the prevention of dislocation movement need not be the only cause of irradiation hardening; changes in the basic lattice C_{44} may be equally effective. (auth) (UK)

28967 INFLUENCE OF CRYSTALLITE SIZE ON THE DIMENSIONAL CHANGES INDUCED IN CARBONACEOUS MATERIALS BY HIGH-TEMPERATURE IRRADIATION. Bokros, J. C.; Guthrie, G. L.; Schwartz, A. S. (General Atomic Inc., San Diego, Calif.). Contract AT(04-3)-167). Carbon, 6: 55-63(Feb. 1968). (GA-8001).

Measurements were made of the dimensional changes induced by fast neutrons in natural graphite, annealed pyrolytic carbon, catalytically graphitized carbon, and turbostratic carbon, for irradiation temperatures below 1300°C. Plots of the rate of change of the crystallite dimensions vs temperature showed the existence of a minimum rate for all except the natural crystals. This minimum rate occurs at a temperature that increases with increasing crystallite size. For the largest crystallite sizes (natural crystals) the rate decreases monotonically with temperature up to the highest investigated (1300°C). For large crystallites (>200 Å) and low irradiation temperatures (~200°C) the rate of dimensional change is insensitive to crystallite size. The rate becomes increasingly dependent on crystallite size as the irradiation temperature is increased. At temperatures near 1200°C the rate varies by over two orders of magnitude for the various crystallite sizes used in the study. The functional dependencies noted from the data are qualitatively consistent with the ideas of Reynolds and Thrower that involve the temperature-dependent heterogeneous nucleation of widely spaced interstitial clusters. (auth) (UK)

28968 HARDNESS OF IRRADIATED GRAPHITE. Brown, R. G. (United Kingdom Atomic Energy Authority, Culcheth, Eng.). Carbon, 6: 27-30(Feb. 1968). (TRG-Report-1503).

The Vickers hardness of a near isotropic reactor graphite was measured before and after neutron irradiation to various doses. The hardness of the irradiated specimens was also measured after annealing at successively higher temperatures. An attempt is made to interpret the results in the light of present knowledge of irradiation damage in graphite. (auth) (UK)

28969 NEUTRON-INDUCED DAMAGE IN BeO, Al_2O_3, AND MgO: A REVIEW. Wilks, R. S. (Atomic Energy Research Establishment, Harwell, Eng.). J. Nucl. Mater., 26: 137-73 (1968). (AERE-R-5596).

The nature of the radiation damage and the irradiation-induced changes in the macroscopic properties of BeO, Al_2O_3 and MgO is reviewed. (auth)

Plastics and Other Materials

Refer also to abstract 27959.

28970 (BMI-X-10233) HEAT-RESISTANT CONCRETE FOR PRESTRESSED-CONCRETE-PRESSURE-VESSEL (PCPV) REACTORS. Quarterly Progress Report, January-March 1968. Birkimer, Donald L.; Lankard, David R.; Fondriest, F. Frederick; Snyder, M. Jack (Battelle Memorial Inst., Columbus, Ohio). Apr. 1, 1968. Contract W-7405-eng-92. 50p. (EURAEC-2022). Dep. CFSTI.

Work performed under United States–Euratom Joint Research and Development Program.

Measurements were completed of the compressive strength and modulus of elasticity of gravel and limestone concretes autoclaved at 250 and 500°F, then subjected to various treatments prior to testing. The effects of prolonged exposure to temperatures of 175, 250, 375, and 500°F on the flexural strength of unsealed gravel and limestone concretes were determined. Specimens for a similar study on sealed concrete were fabricated and are currently undergoing thermal treatments before testing. Measurements of the compressive strength and modulus of elasticity of sealed concrete at temperatures up to 500°F were begun using a specially designed pressure chamber. Time-dependent strains in unsealed gravel and limestone concrete at room temperature and 250°F and under various moisture/stress conditions are being measured. Specimens and equipment necessary for similar measurements at 500°F were prepared. Specimens and equipment necessary for measurements of time-dependent strain in stressed and unstressed sealed concrete at 70, 250, and 500°F were also prepared. Studies of the effects of heat exposure up to 500°F on the microstructure and chemistry/mineralogy of gravel and limestone concretes were initiated. Measurements were completed of the compressive strength and modulus of elasticity of sealed specimens of gravel concrete modified with additions of an artificial pozzolan (fly ash), which was heated at temperatures up to 500°F. Specimens for the measurements of the flexural strength of the modified concrete under similar testing conditions were prepared and cured. The temperature in the center of the 6 ft dia limestone concrete sphere used in the study of moisture movement in mass concrete under the influence of a temperature gradient was raised from 175 to 250°F and is being maintained at 250°F. Temperature and moisture movement (as indicated by changes in electrical resistivity of the concrete) are being monitored at numerous sites in the sphere as a function of time. The change in weight of the sphere as a function of time is also being recorded. (auth)

28971 (Y-1609) ANISOTROPIC PHOTOELASTIC ANALYSIS OF FIBER REINFORCED COMPOSITE MATERIALS. Knight, Charles Eugene Jr. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). Mar. 19, 1968. Contract W-7405-eng-26. 82p. Dep. CFSTI.

A theoretical and experimental investigation was made of the photoelastic effect in a transparent anisotropic material. The material is a fiber glass reinforced epoxy resin, and vacuum impregnation techniques were developed to render the material transparent. Isochromatics and isoclinics in the material when subjected to both uniaxial and biaxial stresses were observed and compared to the predicted data. Isochromatic data proved to be representable by an orthotropic stress-optic law. Isoclinics were predictable, but at a given point in a stressed model the isoclinic angle depends on both the angle of principal stress directions and

the ratio of principal stress magnitudes. Thus, the isoclinics do not directly give the principal stress directions. At this point, the anisotropic photoelasticity solution cannot be determined. (auth)

28972 STUDY OF THE NATURE OF HARDENING CENTERS IN IRRADIATED LITHIUM FLUORIDE. Cagnon, M. pp 79-83 of Fragilite et Effets de l'Irradiation. 10e Colloque de Metallurgie, Saclay, France. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay. Paris, Presses Universitaires de France, 1967. (In French).

From 10th Symposium on Special Metallurgy Brittleness and Irradiation Effects, Saclay, France. See CONF-660656.

The nature of hardening centers in γ-irradiated LiF was studied by compression tests and optical absorption measurements. The development of the hardening centers was investigated by isochronous annealings carried out on the sample at different temperatures. For each annealing temperature, the elastic limit of crystals irradiated at different doses between 4×10^6 and 10^8r was studied. The relations between the elastic limit and the number of F centers takes the form $\tau = K n_F^{\frac{1}{2}}$ the proportionality factor K varying with temperature for annealings above 200°C. The development is accompanied by a large variation in the form of the deformation curves and in the aspect of the slip bands. These results can be interpreted by considering that the hardening centers are fluorine interstitials formed during irradiation at the same time as the F centers, their development for annealings above 200°C corresponding to a coagulation into agglomerates of which the size depends only on the annealing temperature and not on the dose received. (auth)

28973 A COMPARISON OF TECHNIQUES FOR THE STUDY OF THE CRYSTALLITE SIZE DISTRIBUTION IN FINE POWDERS. Hickman, B. S. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). J. Aust. Ceram. Soc., 3: 21-7 (May 1967).

The application of x-ray diffraction techniques to the study of the particle size distribution and lattice strain in fine powders is discussed and illustrated with measurements on a thoria gel. Results obtained by x-ray techniques are compared with those obtained from transmission electron microscopy. Provided the real significance of the x-ray measurements is taken into account, then excellent agreement exists between the techniques. (auth)

28974 ELECTRICAL DISCHARGES IN ELECTRON-IRRADIATED PLATES OF PLEXIGLAS AND EPOXY PLASTIC. Dokopoulos, Petros; Marx, Erwin (Technische Hochschule, Brunswich). Elektrotech. Z., A, 88: 617-19(Dec. 8, 1967). (In German).

The results of experiments on electron-irradiated insulation materials are reported. An interpretation of different figures arrived at by different arrangements of the discharge was sought in terms of electron migration in solids. Charge and current measurements were carried out, and the influence of intermediate layers on the discharge patterns was explored. The shorter the time between irradiation and discharge, the more pronounced the channels formed in the plastic. The great majority of the electrons flow in the same channels, which generally extend in a 3 mm plane from the point of contact. Partial discharges causing branching into other layers of the insulator were observed. A typical current measurement showed that maximum current is reached in 70 nsec; these current values range from 60 to 100 amp, with highest values observed for the smallest interval between irradiation with accelerated electrons and discharge, about 1 min. Irradiated epoxy plastics were discolored, but the color was removed by heating at 70°C for 3 hr. (BBB)

28975 EFFECT OF ELECTRONS ON NH_3 ADSORBED ON A W(100) SURFACE. Anderson, J.; Estrup, P. J. (Bartol Research Foundation of the Franklin Inst., Swarthmore, Pa.). Surface Sci., 9: 463-7(Jan. 15, 1968). (NYO-3830-2).

The effects of electron impact in an NH_3 layers adsorbed on tungsten (100) surfaces are discussed. It was found that when NH_3 is adsorbed to saturation at room temperature and the surface is heated to ~500°K, H_2 and NH_3 are released, leaving on the surface a quantity of H and N equal to half a monolayer of NH_2. (P.G.C.)

28976 USE OF CROSS-LINKED POLYETHYLENE IN ELECTRICAL ENGINEERING. Somogyi, A.; Dobo, J. Muanyag Gumi, 4: No. 6, 177-80(1967).

Experimental magnet coils were prepared by using an experimental amount of polyethylene film cross-linked by irradiation with a ^{60}Co radiation source. As a spacing material it replaced kraft paper and as protective covering it substituted viscose film. Because of the better exploitation of the available space by the turns, the coils were more slender and proved to be completely safe in operation even under tropical conditions since their resistance never dropped below 5.10^6 ohms. The obtained insulation resistance is about 3 orders higher and polyethylene-insulated coils regain their original resistance much faster after removal from the environmental chamber. Cross-linked polyethylene film was used for the Samicatherm insulation of the stator of locomotive traction motors as a separating material while baking Samicatherm with bitumen at 170°C. The cross-linked polyethylene film wrapped around the parts to be protected welds to a continuous separating layer by the effect of heat treatment thus providing excellent protection for the insulation; it can be easily removed after completion of the heat treatment. The same outstanding results were obtained in the protection of the shafts of the rotating parts to be impregnated. (Hung. Tech. Abstr.)

28977 MEASUREMENT OF THE PERMEABILITY OF THICK MEMBRANES TO LIQUEFIED HYDROCARBONS BY A RADIOACTIVE TRACER TECHNIQUE. Evans, R. (Shell Research Ltd., Chester, Eng.). J. Appl. Chem. (London), 18: 92-6(Mar. 1968).

A radioactive tracer technique was devised to measure the permeability of thick membranes and layers of synthetic rubbers and glass-fibre laminates to liquefied hydrocarbons. The technique involves the use of the tritium-labelled hydrocarbon, prepared by treating the appropriate Grignard reagent with tritiated water. The labelled hydrocarbon is transferred to a thermostatted permeability cell, and permeate is trapped in a vial which contains liquid scintillation phosphor and is cooled in liquid air. The trapped permeate is measured by liquid scintillation counting of the sealed vial. Such measurements, made over an appropriate period, allow permeability constants to be calculated. Propane transfer rates down to 10^{-10} g/hr were measured, with membranes of thickness ranging from about 0.5 to 1.5 mm, giving permeability constants of the order of 10^{-11} g cm^{-1} hr^{-1} atm^{-1}. Abnormal rate/time curves were found for some membranes. Factors affecting the accuracy of the measurements, and the safety precautions necessary, are discussed. Extension of the technique to the study of hydrocarbons of low boiling point, such as methane, is considered. (auth) (UK)

28978 RADIATION RESISTANCE OF PLASTICS. II. LONG TERM IRRADIATION TESTS ON PVC PIPES. Wilski, H.; Gaube, E.; Roesinger, S. (Farbwerke Hoechst AG., Frankfurt am Main). Kerntechnik, 10: 142-4(Mar. 1968). (In German).

Polyvinyl chloride pipes were irradiated with gamma rays at a very low absorbed dose rate (450 to 670 rad/hr) for over three years. Subsequent creep rupture tests showed that, for PVC 100 pipes used as pressure pipes, the maximum permissible absorbed dose is about 8 Mrad. Beyond this dose the pipes become very brittle. The results obtained were independent of whether the pipes were filled with water, dilute sulfuric acid, dilute sodium hydroxide solution, or air during irradiation. (auth)

28979 PROCESS FOR MAKING GRAPHITE. Tully, Geoffrey R.; Schwartz, Alan S.; Bailey, Leonard (to United States Atomic Energy Commission). U. S. Patent 3,383,439. May 14, 1968.

A process is described for making compact graphite products by heating the green article under restraint, cooling the article and relieving the restraint, and reheating. (AEC)

PHYSICS (GENERAL)

Astrophysics and Cosmology

Refer also to abstracts 29207, 29221, 29222, 29310, 29312, 29343, 29347, 29350, 29370, 29378, 29679, 29702, and 29765.

28980 (LPTHE-TH-68/7) SELF-CONSISTENT HOMOGENEOUS ISOTROPIC COSMOLOGICAL MODELS. I. GENERALITIES. Hakim, Remi (Paris Univ., Orsay (France). Laboratoire de Physique Theorique et Hautes Energies). Mar. 1968. 26p. Dep.

Self-consistent models of uniform universes are provided by coupling Einstein's equations to the one-particle Liouville equation: correlations between the "particles" of the cosmic gas are thus neglected. As a consequence an equation of state is not needed in the theory but rather provided from these statistical considerations. It is shown that an expanding self-consistent uniform Universe behaves asymptotically as the relativistic polytrope $p \sim \mu^{4/3}$ and finally as an expanding Friedmann Universe. Near the possible singularity R = 0 (R = scale factor) self-consistent models are hot models. Friedmann models are shown to be a particular case of self-consistent models. (auth)

28981 (SC-T-68-1518) SOLAR NEUTRONS: EXPERIMENT ORGANIZED BY THE ARGENTINE NATIONAL CENTER OF COSMIC RADIATION (CNRC). Ghielmetti, H. S. Translated by Marcel I. Weinreich (Sandia Corp., Albuquerque, N. Mex.), from Paper Presented at the International Solar Eclipse Symposium, Brazil, February 5–9, 1968. 9p. (CONF-680208–2). Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

An experiment planned by the CNRC for the total solar eclipse of November 12, 1966 is briefly described. Its main purpose was to determine the presence, near the top of the atmosphere, of a flux of fast neutrons of solar origin. The high geomagnetic cutoff of the region covered by the total eclipse, and, as a consequence, the low background of albedo and secondary neutrons; and, on the other hand, the relatively large dimensions of the detector to be used, should permit an establishment of upper limits for the solar fast neutron flux, by observing its variations during the partial and total coverage of the Sun by the Moon. Strong winds blowing at the time of launching destroyed the 15,000-m^3 plastic balloon, thus aborting the project. (auth)

28982 INVESTIGATION OF SOLAR RADIO BURSTS IN THE FREQUENCY RANGE 536 TO 2000 Mc. Tlamicha, A.; Olmr, J.; Furstenberg, F.; Kruger, A. (Astronomical Inst., Prague. Heinrich Hertz Inst., Berlin). Bull. Astron. Inst. Czech., 18: No. 2, 70-7(1967). (In Czech).

A statistical investigation of solar bursts of 10-cm wavelength (dm-bursts) was made on the basis of single frequency observations at 536, 808, 1500, and 2000 Mc. From 1959 through 1961, 1620 bursts were examined. In some of the bursts bandwidth increased with wavelength; these bursts included both continuum and non-continuum radiation. The dm-bursts were compared with associated cm- and meter-bursts, chromospheric flares, and sudden ionospheric disturbances (SID). The association between m-type III bursts and dm-bursts increased with the increasing extent of frequency as well as with the wavelength of the dm-bursts. A percentage of flare associations increasing with frequency indicates that at 2000 Mc a certain amount of non-flare-associated bursts may exist. Average spectra for various kinds of dm-bursts were derived and their characteristics evaluated. (ATD)

28983 SCATTERING OF MASSLESS SCALAR WAVES BY A SCHWARZSCHILD "SINGULARITY". Matzner, Richard A. (Univ. of Maryland, College Park. Cambridge Univ., Eng.). J. Math. Phys. (N. Y.), 9: 163-70(Jan. 1968).

The scattering and absorption of scalar waves satisfying the equation $\phi^{;\mu}_{;\mu} = 0$ in the Schwarzschild metric are investigated. This problem was previously considered by Hildreth. It is found that for a Schwarzschild mass m, there are the following cross sections in the zero-frequency limit for s-waves: σ(absorption) = 0, $d\sigma/d\Omega \simeq [c + \frac{1}{2}(2m) \ln (2m\omega)]^2$, where c is a constant of order m. These results disagree with the previous calculation. A method of solution is shown for the equation. Its limiting (Newtonian) form, with suitable identification of the coefficients, is the problem of Coulomb scattering in nonrelativistic quantum mechanics. By demanding coordinate conditions which for large l allow the usual Coulomb results in a partial-wave expansion, one is able to define a partial-wave cross section. The (summed) differential cross section for small frequencies inherits the logarithmic behavior of the s-wave part, which is the only contribution explicitly calculated. (The $l \neq 0$ contributions and the behavior of the cross sections for $\omega \neq 0$ are qualitatively indicated.) Cosmological considerations are given which cut off this divergence. (auth)

28984 THE INTERPLANETARY MAGNETIC FIELD, SOLAR ORIGIN, AND TERRESTRIAL EFFECTS. Wilcox, John M. (Univ. of California, Berkeley). Space Sci. Rev., 8: 258-328 (Apr. 1968).

Many observations related to the large-scale structure of the interplanetary magnetic field, its solar origin and terrestrial effects are discussed. During the period observed by spacecraft, the interplanetary field was dominated by a sector structure corotating with the Sun in which the field is predominantly away from the Sun (on the average in the Archimedes spiral direction) for several days (as observed near the Earth), and then toward the Sun for several days, etc. The average sector appears to be a coherent entity with internal structure such that its preceding portion is more active than its following portion. Cosmic rays corotate with the interplanetary field, and there are differential flows associated with the sector pattern. Profound effects on geomagnetic activity and the radiation belts are produced as the sector pattern rotates past the Earth. The solar origin of the sector pattern is discussed. The solar source may be associated with the large-scale weak background photospheric fields observed with the solar magnetograph. It is suggested that there may be a rather continual relation between this solar structure and terrestrial responses, of which the recurring M-Region geomagnetic storms are just the most prominent example. (auth)

28985 TYPE-IV BURSTS AND ASSOCIATED ACTIVE REGIONS. Kleczek, J.; Olmr, J. (Astronomical Inst., Ondrejov, Czechoslovakia). Bull. Astron. Inst. Czech., 18: No. 2, 68-9 (1967). (In Czech).

The occurrence of type-IV bursts and their association with active regions were investigated on the basis of data obtained during the latest minimum of solar activity. The photospheric surrounding of a spot group in which the triggering flare occurred is considered; the distances between type-IV producing groups and their neighboring groups, as well as the distribution of type-IV bursts in relationship to the type of group in which the triggering flare occurred are evaluated. The analysis leads to the conclusion that type-IV bursts apparently evade isolated sunspot groups, and are produced by the magnetic field of a whole region consisting of two or more neighboring active centers (spot groups) whose magnetic fields are interlinked in the corona. Filtergrams of green coronal structures taken at Sacramento Peak Observatory show good examples of the connecting arches. Interconnections are also indicated by solar prominences. The supposition is that it is in the magnetic field connecting the active centers through the high regions of the corona that the relativistic electrons are captured and spiral to emit type-IV synchrotron radiation. (ATD)

28986 KEY TO MYSTERY PULSES: ROTATING NEUTRON STARS. Davis, Harold L. Sci. Res., 3: No. 10, 21-5(May 13, 1968).

A new model by Gold for the rapidly pulsating radio stars is reviewed. The model consists of a neutron star rotating once per second with a point source of plasma on its surface. (W.D.M.)

28987 SOLAR AND GALACTIC COSMIC RAY SATELLITE EXPERIMENT. Althouse, William E. (California Inst. of Tech., Pasadena); Stone, Edward C.; Vogt, Rochus E.; Harrington, Timothy H. Contract NAS5-9312. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: 229-37(Feb. 1968).

From 14th Nuclear Science Symposium, Los Angeles. See CONF-671026.

A cosmic-ray instrument for NASA's OGO-F spacecraft is described. The experiment consists of three charged particle detector systems which are designed to measure the spectra and chamical composition of galactic and solar cosmic rays over selected energy intervals. Two of the detector systems, the ΔE-Range and ΔE-Cherenkov telescopes, will measure the galactic flux and smaller solar flare fluxes, while a third detector system, the flare telescope, will measure larger fluxes. (auth)

28988 THEORY OF OPTIMUM DRILLED SCINTILLATION COLLIMATORS FOR X-RAY ASTRONOMY. Aitken, Donald W. (Stanford Univ., Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: 214-28(Feb. 1968).

From 14th Nuclear Science Symposium, Los Angeles. See CONF-671026.

In order to study unambiguously the x-ray spectra from single

celestial x-ray sources located amid several closely spaced sources, some form of angular collimation must be used on an x-ray telescope flown at balloon altitudes or higher. A popular design featuring high background rejection consists of closely spaced holes drilled through a block of scintillator material. Several general cross-sectional geometries for these holes are explored, presenting features in mathematical and graphical form such as transmission efficiency; angular resolution; residual detector area after collimation; and optimum spacing between detector and collimator. The influence of the hole shape on collimator leakage and on signal to background ratio is discussed. Collimator geometries to fulfill specific needs are deduced from the curves. A symmetric hourglass hole shape is shown to provide most nearly an optimum compromise of desirable features. (auth)

28989 ABSORPTION LINES OF NEUTRAL SILICON IN THE SOLAR SPECTRUM. Lambert, D. L.; Warner, B. (Oxford Univ.). Mon. Notic. Roy. Astron. Soc., 139: 35-101(1968).

A comprehensive description of the occurrence of Si I lines in the solar spectrum in the wavelength range 2935 to 25,578 Å is presented. Theoretical equivalent widths are calculated using a detailed curve of growth method and the f-values given in Mon. Not. Roy. Astron. Soc. 139: 1-34(1968). Si I is found to account for, or is an important contributor in, about 550 solar lines. Some 200 of these are new identifications. Many more Si I lines of moderate strength will appear in the solar spectrum but are masked by telluric absorption. It has been found possible to locate 32 new energy levels in Si I, mostly in the 7f, 8f, and 9f configurations. Transitions to these levels account for some previously unidentified, but moderately strong, solar lines. (auth) (UK)

28990 SOLAR EVENT AT TWO DECIMETRE WAVELENGTHS. Mullaly, R. F.; Watkinson, A. (Univ. of Sydney). Nature (London), 218: 539-41(May 11, 1968).

The solar event described in Nature, 218: 536-9 (May 11, 1968) was observed with high angular resolution at two-decimetre wavelengths. (auth)(UK)

28991 80 MHz PHOTOGRAPHY OF THE ERUPTION OF A SOLAR PROMINENCE. Wild, J. P.; Sheridan, K. V.; Kai, K. (CSIRO, Sydney). Nature (London), 218: 536-9(May 11, 1968).

Photographs of the eruption of a solar prominence made using its radiation at 80 MHz by the Culgoora radio heliograph revealed relationships between the prominence, a flare, and solar radio emissions. (auth)(UK)

28992 RADIAL OSCILLATION PERIODS FOR HAMADA–SALPETER MODELS OF WHITE DWARFS. Skilling, J. (Cavendish Lab., Cambridge, Eng.). Nature (London), 218: 531-2 (May 11, 1968).

Calculations of the oscillation periods for white dwarf models show that, until instability is reached, the period depends very little on the composition or the equation of state. (auth)(UK)

28993 TIME RESOLVED PHOTOMETRY IN TWO PULSED RADIO SOURCE FIELDS. Borgman, J.; Koornneef, J. (Kapteyn Observatory, Roden, Netherlands). Nature (London), 218: 531 (May 11, 1968).

A search for optical pulsations from two of the pulsating radio sources was made, with negative results. (auth)(UK)

28994 NEW VALUE FOR THE SOLAR CONSTANT OF RADIATION. Drummond, A. J. (Eppley Lab., Newport, R. I.); Hickey, J. R.; Scholes, W. J.; Lane, E. G. Nature (London), 218: 259-61(Apr. 20, 1968).

The solar constant of the Earth is the extraterrestrial flux of the Sun's energetic radiation integrated over all emission wavelengths and referred to one AU. An accurate knowledge of this quantity and its spectral components is an important requirement in the design and space simulation testing of spacecraft. An experiment is described the basic objective of which is to make available a series of multichannel radiometers calibrated by exposure to the Sun at altitudes above the ozonosphere (>50 km.), employing rocket research aircraft. Instrumentation for the new measurements is briefly described. On October 17, 1967 the first direct measurement of the solar constant was obtained at ~82 km., its value being 136.1 mW/cm^2., which agreed well with a series of supporting measurements made using conventional jet aircraft (after atmospheric extinction corrections). (UK)

28995 THE SOLAR WIND: THEORIES, MEASUREMENT RESULTS, MEASUREMENT PROBLEMS. Rosenbauer, H. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Raumfahrtforschung, 12: 38-40(Jan.-Mar. 1968). (In German).

The characteristics of the solar wind as postulated by theorists and confirmed by experimental measurements are outlined. The principal results obtained from satellite space probe measurements are reported. The development of instruments for the measurement of the solar winds is illustrated by a description of the "plasma cup" and the Wolfe electrostatic analyzer. (J.S.R.)

28996 RADIOGALAXIES AND QUASARS. II. Sandage, Allan R. (Cornell Univ., Ithaca, N. Y.). Fiz. Szemle, 18: 10-12(Jan. 1968). (In Hungarian).

If the red shift of quasars is due to cosmological reasons, about 80% of the events involved in the creation of a Friedman-type universe may be reconstituted. If it is accepted that the quasars are located at Hubble distances, they are the largest radiation sources. On the basis of an initial energy of 10^{62} erg and a transformation efficiency of 1%, about 10^{10} $M_\odot$ mass of hydrogen must have been transformed into helium, in order to cover the energy involved in emission of the largest quasar. This question and the rapid light emission variations of quasars raise doubts about the validity of a cosmological explanation of the red shift. The current controversy is a continuation of the problem, first raised in the 1920's: instead of speculating on the distance between galaxies, the question is whether the quasars are localized sources. According to Ryle, the quasars possess a dual structure, like the radio galaxies. Heeschen argues that the surface radioluminance of quasars is continuously adjusted to the corresponding values of radio galaxies, if they are represented as a function of the absolute radioefficiency. The observed properties of quasars and radio galaxies are less important than solution of the fundamental mystery or their source of energy. (TTT)

28997 NEUTRON STAR. Williams, I. P. (Reading Univ., Eng.). Phys. Lett., 26A: 646-7(May 6, 1968).

It is shown that the radio observations of a rapidly pulsating source are consistent with its identification as a blue star. The determined position of this star in the HR diagram places it in the dwarf region. (auth)

28998 RADIOGALAXIES AND QUASARS. I. Ryle, Martin (Cavendish Lab., Cambridge, Eng.). Fiz. Szemle, 18: 5-10 (Jan. 1968). (In Hungarian).

Radiotelescopic studies revealed the existence of a continuous background emission, originating in our Galaxy or from extragalactic sources, and also of about 8000 compact sources. A few hundred of these latter sources were more closely examined; these studies indicated that some of them are located in our Galaxy and represent the residue from supernovae explosions. Because of their similarity with starlike objects, some sources were designated as quasistellar sources or quasars. The quasars are classified on the basis of their radio intensity, variations in the short, <10 cm, region, and sharp cuts in the radio spectrum. According to the simplified Longair–Ryle model on the evolution of radio galaxies, it is assumed that large amounts of energy, about 10^{61} erg, is suddenly liberated in the center of the system, resulting in the emission of plasma clouds in two opposite directions. The recently discovered isotropic microwave background radiation, with a black-body spectrum, is an independent proof of the conclusions of the developmental cosmology, as it refers to the residual radiation of the "fireball," assumed to exist in the early, highly condensed stage of the evolution of the Universe. (TTT)

28999 CREATION OF THE SMALLER CELESTIAL BODIES IN THE SOLAR SYSTEM. Herczeg, Tibor (Univ., Hamburg). Sterne Weltraum, 6: 86-9(Apr. 1967). (In German).

Development of a cosmogony for the asteroids, comets, and meteoritic bodies of our solar system is discussed. Considerations are given which support the hypothesis that the creation of asteroids is due to repeated collisions between two asteroids. It is seen that such collisions are not only possible but even probable. Orbital data are examined which support Oort's hypothesis of the existence of a "distant" comet cloud from which individual comets are ejected (due to interference of neighboring systems) along nearly parabolic elliptical orbits, to appear as new comets when their orbits cross the solar system. (IAA)

29000 NEUTRAL-POINT REGION IN PETSCHEK'S MODEL OF MAGNETIC-FIELD ANNIHILATION. Friedman, M.; Hamberger, S. M. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). Astrophys. J., 152: 667-70(May 1968).

In Petschek's model of magnetic-field annihilation an anomaly occurs near the neutral point if the diffusion is determined by classical electron scattering. A self-consistent picture emerges, which removes this anomaly, if one considers the possibility of collective plasma interactions (generated by a two-stream instability), in which case the conductivity is greatly reduced by electron-wave scattering. Experimental evidence to support this suggestion is offered. (auth)

29001 NEGATIVE POLARIZATION IN THE ZODIACAL LIGHT. Weinberg, J. L.; Mann, H. M. (Univ. of Hawaii, Kula). Astrophys. J., 152: 665-6(May 1968).

A search for negative polarization was conducted at Mount Haleakala, Hawaii, on five nights in May (evening) and October (morning) of 1967 with a photoelectric polarimeter. At the measured wavelengths no cases of negative polarization were found at elongations between 35° and 90° in the ecliptic. Various scanning configurations were used, including vertical circles in October when the ecliptic was normal to the horizon, to ensure that the regions in question were adequately observed in both space and time. (W.D.M.)

29002 INTERPRETATION OF MERCURY OBSERVATIONS AT WAVELENGTHS OF 3.4 AND 19 MM. Morrison, David (Harvard Univ., Cambridge, Mass. Smithsonian Astrophysical Observatory, Cambridge, Mass.). Astrophys. J., 152: 661-4(May 1968).

Observations made at wavelengths of 3.4 and 19 mm of the microwave phase effect of Mercury are both found to be compatible with a single, basically lunar, set of thermal properties for the planet. (auth)

29003 LITHIUM DESTRUCTION AND ROTATIONAL BRAKING. Conti, Peter S. (Univ. of California, Santa Cruz). Astrophys. J., 152: 657-9(May 1968).

It has been argued that the torque exerted by the solar or stellar wind will produce differential rotation and therefore turbulence below the convective zone, which will lead to mixing of material to regions of higher temperature where lithium could be destroyed. A possible confirmation of this suggestion is pointed out. One would suppose that if the rotational braking mechanism leads to a mixing of material below the convective zone, a relation between the rotation of a star and its lithium content would then be observed. Those stars that still had appreciable rotation would have less lithium destruction. Since the rate of lithium destruction is a function of spectral type, it is necessary to consider stars in only a narrow spectral range. Early G stars, of solar type, are used in the discussion. (W.D.M.)

29004 ABSORPTION IN THE DIRECTION OF M17. Dickel, Helene R. (Univ. of Illinois, Urbana). Astrophys. J., 152: 651-5 (May 1968).

Calibrated Hα isophotes of the emission nebula M17 were compared with three radio maps at λλ3.4 mm, 2 cm, and 2.8 cm. The values of the visual absorption which were obtained for four positions in the nebula range from 4 to 7 mag. (auth)

29005 SOME COMMENTS ON A PAPER "LEAST-SQUARES FIT OF A GAUSSIAN TO RADIO SOURCES" BY S. VON HOERNER. Jauncey, David L. (Cornell Univ., Ithaca, N. Y.). Astrophys. J., 152: 647-9(May 1968).

The method which is widely used in many of the sky surveys for the determination of radio-source flux valves is a least-squares fitting of a Gaussian to an observed source scan. A general computer program for doing this fitting automatically has recently been made available for general use by von Hoerner (1967). The derivations of this method, however, overlook an important point which results in the production of biased estimates of source fluxes. This bias is of particular importance when an examination of the number-flux curves for the various sky surveys is to be undertaken. The form of the bias is discussed. (W.D.M.)

29006 FURTHER OBSERVATIONS OF VARIABLE RADIO SOURCES. Kellermann, K. I.; Pauliny-Toth, I. I. K. Astrophys. J., 152: 639-46(May 1968).

Following the discovery of the time variations in the intensity of quasars, a program of monitoring the flux densities of a number of radio sources between wavelengths of 2 and 40 cm is given. For several sources which show relatively large fluctuations of intensity, the dependence of the variations on wavelengths has been determined in some detail. In selection of sources to be observed, emphasis was placed on sources with flat radio spectra. The observational program is described and results are given for 25 sources. (W.D.M.)

29007 INVESTIGATIONS OF THE ASSOCIATION BETWEEN RADIO SOURCES AND PECULIAR GALAXIES. Arp, Halton (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. J., 152: 633-7(May 1968).

The results of van der Laan and Bash in the preceding paper are examined and it is found that for the most part they do not test the hypothesis of Arp (1967); and insofar as their results do apply they tend to support the association reported in the original paper. Some comments are presented which offer additional evidence for the reality of that association. (W.D.M.)

29008 RADIO SOURCES AND ARP'S PECULIAR GALAXIES. van der Laan, H.; Bash, F. N. (National Radio Astronomy Observatory, Green Bank, W. Va.). Astrophys. J., 152: 621-31(May 1968).

The claim that there is an excess of radio sources in the neighborhood of Arp's peculiar galaxies, arranged as aligned pairs centered on those galaxies, has been extensively tested. The distributions of radio sources and of radio-source pairs near positions in the Arp Atlas and near equally clustered but arbitrarily positioned control catalogue points were compared. Considering circles ranging in radius from 1° to 10° by the addition of successive annuli of 1° width, radio sources, source pairs, and aligned source pairs were identified and counted. In all cases the number of aligned pairs constitutes that fraction of all pairs expected for random radio-source distributions. There is no preferred alignment at all. Among the control catalogues the Arp catalogue is statistically undistinguished for purposes of radio-source and source-pair counts in all circles from 1° to 3° and from 4° to 10°. In the 4° to 3° annulus there is an excess of sources, 2 standard deviations above the population mean, an excess which has a statistical significance of 4%. There is no excess of aligned pairs inside 4° circles. The fact that the excess count occurs in annuli whose angular diameter is 8° emphasizes the fluctuation's chance character. The number of radio-source pairs increases rapidly with increasing source number density, and it is suggested that this steep dependence conspired with the chance fluctuation to give rise to Arp's hypothesis. (auth)

29009 POLARIZATION OF THE JUPITER RADIATION AT 18 Mc/s. Barrow, C. H.; Morrow, D. P. (Florida State Univ., Tallahassee). Astrophys. J., 152: 593-608(May 1968).

Measurements of both the axial ratio r and the degree of polarization m were made at 18 Mc during two apparitions of Jupiter. Distributions of $|r|$ and m indicate that some 45% of the bursts are circularly polarized and that the degree of polarization is generally rather high, some 80% of the bursts having polarization fractions greater than 0.7. The results are consistent with some of the predictions of the Doppler-shifted cyclotron theory and in good agreement with two-component measurements made previously by various workers. The over-all accuracy of the measurements is discussed; also the effect of assuming complete polarization in two component measurements. A number of the circularly polarized bursts contain a randomly polarized component and thus appear to be elliptically polarized if only left and right components are measured. (auth)

29010 EMPIRICAL DETERMINATION OF THE CONTINUUM SOURCE FUNCTION IN THE SOLAR PHOTOSPHERE. Waddell III, J. H. (Dublin Inst. for Advanced Studies). Astrophys. J., 152: 577-92(May 1968).

Limb-darkening observations of the solar photospheric continuum were reanalyzed. A persistent discrepancy between theoretical and empirical absorption coefficients was exhibited. It is shown that the discrepancy cannot reasonably be attributed to observational errors, errors in the theoretical or experimental cross-sections, or to an anomalous population of the negative hydrogen ion. However, the disparity is removed if a Kothari source function, rather than a Planck source function, applies in the solar photosphere. The magnitude and variation of the Kothari parameter are estimated. (auth)

29011 OBSERVATIONAL STUDY OF THE HYDRODYNAMICS OF THE LOWER SOLAR PHOTOSPHERE. Frazier, Edward N. (Univ. of California, Berkeley). Astrophys. J., 152: 557-75(May 1968).

Velocity and temperature fluctuations in the solar photosphere were studied using a series of high-resolution spectrograms of the same area on the surface of the Sun at intervals of 20 sec for 55 min. The observations were made with the McMath solar telescope at Kitt Peak National Observatory. Doppler shifts and intensity fluctuations were measured on every frame for three lines, Si II λ6371.36, Fe λ6364.38, and Fe λ6355.04, and their temporal properties were studied using Fourier analysis techniques. The use of these lines allowed the author to study the Fourier properties as a function of altitude in the range from the convection zone to the temperature minimum. The power spectrum of the velocity fluctuations showed a large amount of the low-frequency, or convective, component. This low-frequency power was about 70% coherent with the granulation, and in phase with it. Furthermore, it was present at all levels of the photosphere, implying a considerable amount of convective overshoot all the way up to the temperature minimum. Specifically, 61% of the power at the level of the Si II line was convective, and 3.5% of this power penetrated to the temperature minimum. The increased Fourier resolution, afforded by the relatively long observing time of 55 min, resolved the oscillatory (300-sec period) component into two components; a very sharp component

with a period of 265 sec, and a weaker, broader component with a period of 345 sec. Both of these periods remain constant with altitude. The relative amplitudes of the two components vary with altitude in the sense that the 265-sec component becomes relatively stronger with height. No vertical phase lags were observed at any frequency; the oscillations must be standing waves. The velocity auto-correlation functions showed that these oscillations are extremely long-lived, probably steady state. The power spectra of the intensity fluctuations showed primarily the convective component, again at all levels. Small amounts of oscillatory power were seen, however, in all intensity power spectra. Even the continuum intensity power spectrum contained 10% oscillatory power. The many pairs of coherence and phase spectra yielded additional details of the hydrodynamics of the various modes. (auth)

29012 ANALYSIS OF THE SOLAR SPECTRUM IN THE SPECTRAL RANGE 33 TO 110 A. Widing, Kenneth G.; Sandlin, Glenn D. (Naval Research Lab., Washington, D. C.). Astrophys. J., 152: 545-56(May 1968).

Approximately 24 ions are identified in the soft x-ray spectrum of the Sun, including Fe VIII, IX, X, XI, XV, XVI, and Ni X and XI. Further identifications of 3p-4s transitions in Fe XII, XIII, and XIV are suggested. Identified as well as unidentified spectral features which enhance with solar activity are pointed out. The lines of the lithium-like ions excited by monopole and quadrupole collisions are very strong. Other examples of multipole excitation are pointed out in the spectra of Mg IX, Si XI, and Fe XVI. Element abundances relative to silicon are derived by the method of Pottasch. For plausible values of the Gaunt factor, the iron-to-silicon ratio is between one and two. The iron and silicon emission maximizes in stages Fe XI and Si X, respectively, indicating a general coronal temperature of 1.7×10^6°K. Quantitative agreement with the previous analyses of the $\Delta n = 0$ transitions (150 to 300 Å) of the iron and silicon ions by Jordan (1966) and Pottasch (1967) is found. (auth)

29013 GRAVITATIONAL COLLAPSE OF ROTATING GASEOUS ELLIPSOIDS. Fujimoto, M. (Columbia Univ., N. Y.). Astrophys. J., 152: 523-36(May 1968).

The work of Rossner on the finite-amplitude oscillation of a Maclaurin ellipsoid is extended to the adiabatic and nonadiabatic gravitational collapse of a rotating uniform gaseous ellipsoid. The problem is made tractable by introducing an appropriate temperature distribution in the initial ellipsoid and by assuming a special formula for the cooling rate of the gas. Solutions can be represented by trajectories in the (a_1,a_2,a_3)-space, where a_1, a_2, and a_3 are the lengths of the three principal axes of the ellipsoid. The adiabatic collapse is characterized by the same trajectories that represent nonlinear adiabatic pulsations. They never reach any plane $a_j = 0$ (j = 1, 2, 3) but are confined within a closed zero-velocity surface. The trajectories in the (a_1,a_2,a_3)-space which represent the non-adiabatic collapse make one or more loops, depending on the cooling rate of the gas and the total angular momentum. They finally reach the plane $a_3 = 0$; thus the ellipsoid ultimately becomes a flat disk. A small, finite, non-axisymmetric perturbation applied to an axisymmetric ellipsoid grows in the course of the collapse. For large angular momentum the resultant figure is a very thin, needle-like ellipsoid. An ellipsoid which initially has three unequal principal axes displays a peculiar gravitational collapse under the constraint of the circulation integral. The configuration may be elongated even if the angular momentum is very small. (auth)

29014 DYNAMIC COLLAPSE OF THE ISOTHERMAL SPHERE. Bodenheimer, Peter; Sweigart, Allen (Princeton Univ., N. J.). Astrophys. J., 152: 515-22(May 1968).

Six evolutionary sequences representing the collapse of a spherical isothermal gas cloud are presented. The character of the collapse is found to be influenced by the ratio of the free-fall time to the sound travel time from the surface of the sphere to the center. The effects of the surface boundary condition and the initial density distribution on the evolution are discussed with reference to this parameter. (auth)

29015 HEAVY-ELEMENT ABUNDANCES AND THE INTERPRETATION OF GLOBULAR CLUSTER CHARACTERISTICS. Simoda, Mahiro (Goddard Inst. for Space Studies, New York); Iben, Icko Jr. Astrophys. J., 152: 509-13(May 1968).

A grid of evolutionary models was constructed for all permutations of the composition parameters Y = 0.35, 0.20, 0.10, 0.0 and $Z = 10^{-3}$, $\frac{5}{3} \times 10^{-4}$, 10^{-5}. Using time-constant loci derived from this grid, a relationship is established between cluster age, initial composition of cluster stars, and the luminosity of stars near cluster turnoff. It is found that a variation in Z by a factor of 5 can affect the determination of cluster age by as much as a variation in Y from 0.35 to 0.10. (auth)

29016 EARLY A STARS. II. MODEL-ATMOSPHERE ABUNDANCE ANALYSIS OF EIGHT STARS IN THE PLEIADES. Conti, Peter S. (Univ. of California, Santa Cruz); Strom, Stephen E. Astrophys. J., 152: 483-92(May 1968).

Stars near spectral type A0, showing anomalously low ratios of Sc II λ4246/Sr II λ4215, are found to be analogous to the classically defined Am stars. This result follows from a detailed model atmosphere study of eight sharp-lined A stars in the Pleiades. For the four Am analogues among these stars, the following anomalies are found: underabundances of carbon, calcium, and scandium; overabundances of strontium, yttrium, zirconium, and barium; and high microturbulent velocities. The analysis shows clearly that these anomalies cannot be attributed solely to inappropriate choices of atmospheric parameters. The normal A stars in the sample show excellent agreement in their element abundances with field A stars such as Vega. (auth)

29017 ANALYSIS OF THE PROFILES OF STRONG LINES IN THREE F AND G SUBDWARFS. Krishna Swamy, K. S. (Goddard Space Flight Center, Greenbelt, Md.). Astrophys. J., 152: 477-82 (May 1968).

The profiles of strong lines of Hβ, Hγ, and λ3933 of Ca II were studied in three subdwarfs. All the profiles for HD 140283 and HD 19445 could be fitted well with $T_e = 5800$°K and $H/M = 100\ (H/M)_\odot$. For HD 219617, all the profiles could be fitted well with $T_e = 5900$°K and $H\ M = 15\ (H/M)_\odot$. The importance of convection in the model-atmosphere calculation and resonance damping in the calculation of hydrogen-line profiles are discussed. (auth)

29018 SPECTRAL-ENERGY CURVES OF SUBDWARFS. I. Johnson, H. L. (Univ. of Arizona, Tucson. Univ. Nacional de Mexico, Mexico City); MacArthur, J. W.; Mitchell, R. I. Astrophys. J., 152: 465-76(May 1968).

UBVRIJHKL observations were made of approximately 150 subdwarfs, normal main-sequence dwarfs, and Hyades main-sequence stars. The red and infrared data make possible determinations of the changes in the UBVRIJHKL magnitudes as the metal lines are removed from Hyades-like stars. In the UBVRI region, the results are quite similar to those obtained by Wildey, Burbidge, Sandage, and Burbidge, and by Sandage and Smith. The U and B magnitudes become brighter as the metal lines are removed; the V, R, I, and J magnitudes become somewhat fainter; and the H, K, and L magnitudes are independent of the metal contents of the stellar atmospheres. (auth)

29019 PHOTOELECTRIC PHOTOMETRY OF HD 116994. Chen, Kwan-yu (Univ. of Florida, Gainesville. Cerro Tololo Inter-American Observatory). Astrophys. J., 152: 453-63(May 1968).

From observations on three nights, the period of HD 116994 was found to be 0.1022623 day. Harmonic analyses were made of the light curves and color curves. The observed mean color indices are: $B - V = +0.393$ and $U - B = +0.137$. The intrinsic color indices are found to be: $(B - V)_0 = +0.270$ and $(U - B)_0 = +0.048$. Pulsation theory yields $\rho = 0.103\ \rho\odot$, and $R = 1.4\ R\odot$. The absolute visual magnitude is estimated to be +2.0, which seems realistic in view of the interstellar reddening and the predictions of the pulsation theory. (auth)

29020 QUANTITATIVE DESCRIPTION OF THE SPECTRA OF THE BRIGHTER FEIGE STARS. Sargent, Wallace L. (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena); Searle, Leonard. Astrophys. J., 152: 443-52(May 1968).

48 Å/mm spectrograms of thirty stars in Feige's (1958) list of blue stars at high galactic latitudes were obtained. Continuous energy distributions were measured for fourteen of these. The spectrograms were classified on a system that used measured equivalent widths, line profiles, and UBV colors, in addition to visual inspection. In the sample fourteen normal A- and B-type stars were found. It is suggested that the spectroscopically normal B stars, whose spectral types range from B3 to B6, are runaway stars that have been expelled from the galactic plane. The spectra of four sdO stars are described and it is estimated that they have $\theta_{eff} \sim 0.12$, $\log g \sim 5.4$, and $M_v \sim +2$. It is pointed out that He II λ4542 and λ4200 vary relative to He II λ4686 in sdO stars and it is suggested that this effect is due to differential Stark broadening. Four sdB stars are described and $\theta_{eff} \simeq 0.17$-0.20, $\log g = 5.5$, and $M_v \sim +3$ are derived for them. The abnormal behavior of the singlet and triplet He I lines in these stars is discussed. Seven stars are classified as Bw (indicating abnormally weak He I lines for their colors). It is shown that it is unlikely that these Bw stars are runaway main-sequence stars of Population I. The evidence that the surface composition of the Bw stars differs from that of the well-studied stars of Population II is discussed and it is concluded that the surface composition of the Bw stars is not the same as that of the material from which they were formed. (auth)

29021 STRUCTURE AND SPECTRUM OF R MONOCEROTIS. Herbig, G. H. (Univ. of California, Santa Cruz). Astrophys. J., 152: 439-41(May 1968).

On ordinary photographs, the object R Monocerotis (at the apex of Hubble's Variable Nebula NGC 2261) appears as a simple nebulous star. At higher resolution, however, R Mon is in fact a minute triangular nebula about 5 in. across. It is possible that a star exists at the southern tip of this structure, but in the red an appreciable fraction of the total light of R Mon certainly comes from the small nebula itself. The shape and orientation of this small triangular nebula continue out into the very large fan of NGC 2261 itself. No normal stellar spectrum has been observed in R Mon: the absorption lines seen at times are those of a transient shell. Several small, very faint, semi-stellar spots lying on the symmetry axis of R Mon–NGC 2261 about 8″ north of the apex have emission spectra. There is no obvious source of excitation; they may be Herbig–Haro Objects. (auth)

29022 HORIZONTAL-BRANCH STARS AND INTERSTELLAR LINES AT HIGH LATITUDE. Greenstein, Jesse L. (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. J., 152: 431-7(May 1968).

Spectra of blue, horizontal-branch stars in globular clusters with weak He I were examined. The K-line was found strong; it is in part interstellar, and sometimes in part caused by the unresolved cluster background of cool stars. Measures of interstellar Ca II in hot stars at high galactic latitude show great strength. K reaches an equivalent width of 0.4 Å near the pole. Preliminary measures of Na I give a similar limit. Most lines show a negative velocity, similar to, but smaller than, that of the high-velocity 21-cm clouds. (auth)

29023 OBSERVATIONS OF 8-GHz CONTINUUM AND HYDROGEN RECOMBINATION LINES IN THE ORION NEBULA. Gordon, M. A.; Meeks, M. L. (Massachusetts Inst. of Tech., Cambridge). Astrophys. J., 152: 417-30(May 1968).

A continuum map, 1° square and centered on Orion A, resolves the region into its optical components NGC 1976 (M42) and NGC 1982 (M43). Line profiles of 94a hydrogen emission (7.792871 GHz) from both objects have Doppler shifts which agree with optical measurements of low angular resolution. These shifts imply a rotation of the central region of NGC 1976 around a generally north–south axis of an angular 2×10^{-14} rad sec.$^{-1}$. Small departures of the line profiles from Gaussian suggest the presence of another H II region lying along the line of sight through the eastern side of NGC 1976 and moving away from the local standard of rest at approximately 30 to 50 km sec^{-1}. Physical conditions within NGC 1976 and NGC 1982 are considered. (auth)

29024 DYNAMICAL MODELS OF PLANETARY NEBULAE. Sofia, Sabatino (Goddard Space Flight Center, New York. Univ. of South Florida, Tampa); Hunter, James H. Jr. Astrophys. J., 152: 405-15(May 1968).

Dynamical models of spherically symmetric, optically thin planetary nebulae were constructed utilizing an accurate numerical scheme and taking account of the thermal behavior of the gas in detail. The evolution of several model nebulae is exhibited and conclusions are drawn regarding some initial conditions that must prevail in the ejected shell. (auth)

29025 MOTION OF GAS AND SPIRAL STRUCTURE. Fujimoto, M. (Columbia Univ., N. Y.). Astrophys. J., 152: 391-404(May 1968).

The gravitational response of a pressure-free gas to the gravitational field of a spiral pattern was examined. In the case of two spiral arms, large-scale bisymmetric fluctuations in the gas density and corresponding bisymmetric flow patterns are generated. When the spiral structure is fixed in space, the gas emerges (enters) along the leading (trailing) side of the arm and the locus of maximum gas density lies between the arms. When that spiral pattern rotates with sufficient angular velocity, the flow pattern of the gas is reversed and the locus of maximum gas density lies near the arm axis. When the position and magnitude of the density perturbation in the gas are identical with those of the mass distribution which generates the assumed spiral field, the pattern becomes self-sustaining. Extensive numerical calculations were made in a search for such self-consistent spiral patterns. For galaxies with not-too-strong central concentration such patterns can be found and their angular velocity determined. The calculations indicate that the number of windings of the arms is primarily determined by the mass fraction of the galaxy in gas or low-velocity stars. (auth)

29026 OBSERVATIONS OF THE ANGULAR STRUCTURE OF RADIO SOURCES. Bash, F. N. (Univ. of Virginia, Charlottesville. National Radio Astronomy Observatory, Green Bank, W. Va.). Astrophys. J., 152: 375-90(May 1968).

Results of two-element interferometer observations of 234 radio sources are given. The interferometer operated at 2695 MHz with five antenna separations from 10000 to 24000λ. Source selection criteria, observing techniques, and reduction procedures are discussed. It is shown that apparently bright quasi-stellar sources have a higher mean fringe visibility than the apparently faint ones, while the apparently bright radio galaxies tend to have a lower mean fringe visibility than the apparently faint ones. The quasi-stellar sources with flat radio spectra have a higher mean fringe visibility than those with steep spectra. No relation was found between mean fringe visibility and redshift for either the quasi-stellar sources or radio galaxies. At least 13% and probably 62% of the sources observed have at least two radiating components. (auth)

29027 VARIABILITY OF THE OPTICAL BRIGHTNESS AND POLARIZATION OF THE QUASI-STELLAR RADIO SOURCE 3C 345. Kinman, T. D.; Lamla, E.; Ciurla, T.; Harlan, E.; Wirtanen, C. A. (Univ. of California, Santa Cruz). Astrophys. J., 152: 357-74(May 1968).

Photometric data obtained from 1965 to 1967 and polarization measurements made in 1967 are given for the variable quasi-stellar radio source 3C 345. An analysis of the observations shows that they are consistent with the optical radiation having three components: A, an essentially unpolarized constant component; B, a component having about 17% linear polarization which varies both in brightness and position angle with a time scale of months; and C, a component which has a high (but undetermined) amount of linear polarization and which has a time-scale of the order of a few days. Component C takes the form of outbursts which have a mean period of about 80 days. There is only one chance in several hundred that this periodicity could come from a random distribution. There is also a pattern in the phases of these outbursts in the 80-day period which indicates the existence of a 321.5-day period. There is about one chance in eighty that this longer periodicity could be fortuitous. It is speculated that the most probable cause of these light variations is the rotation of a single massive body or perhaps the orbital motion of a close binary system in an optically thick envelope. It is presumed that the slowly varying component arises from an extended region on the object, while the more rapidly varying component is caused by smaller active regions (which radiate non-isotropically) in transit across the face of the object. (auth)

29028 SOLAR IRON LINES AT 182 A. Fawcett, B. C.; Gabriel, A. H.; Jordan, C. (United Kingdom Atomic Energy Authority, Abingdon. Eng.). Astrophys. J., 152: L119(May 1968).

Following the recent communication by Zirin (Astrophys. J., 151: 383 (1968)), it was felt necessary to clarify the position regarding the identity of the intense solar emission at 182 Å. Zirin states that the Fe X line at 182.3 Å was measured at 182.2 Å and wrongly identified by the authors as Fe XI. It is felt that this statement is in error, since he has overlooked the fact that two resolved solar lines are seen near this wavelength. (W.D.M.)

29029 CAN THE OBSERVED MICROWAVE BACKGROUND BE DUE TO A SUPERPOSITION OF SOURCES? Gold, Thomas; Pacini, Franco (Cornell-Sydney Univ. Astronomy Center, Ithaca, N. Y.). Astrophys. J., 152: L115-18(May 1968).

The idea that the background may result from the superposition of unresolved extragalactic radio sources was originally dismissed because the summed flux of all known radio galaxies falls short of the observations by a large factor. The question remains, however, whether radio sources with different properties exist that have so far gone largely undetected except for the summation of the flux from many of them. It is the purpose of this paper to explore what the properties of such sources would have to be were they to account for this microwave radiation. (W.D.M.)

29030 SPECTRAL VARIATIONS IN THE GALAXY NGC 4151. Morgan, W. W. (Univ. of Chicago); Smith, Harlan J.; Weedman, Daniel. Astrophys. J., 152: L113-14(May 1968).

Observations of the spectrum of the nuclear region of the Seyfert galaxy NGC 4151 in 1956 and 1968 show that the G-type absorption spectrum present in 1956 has now disappeared. (auth)

29031 ABSORPTION-LINE SPECTRUM OF THE QUASI-STELLAR OBJECT PHL 5200. Burbidge, E. Margaret (Univ. of California, San Diego). Astrophys. J., 152: L111-12(May 1968).

A spectrogram of PHL 5200 is described. Narrow Si IV absorption lines with $z = 1.9502$ are now visible within the broad absorption band, and this may represent a change in the spectrum in the year which has elapsed since previous observations were made by Lynds. (auth)

29032 SPECTROSCOPIC AND PHOTOMETRIC DATA FOR A SAMPLE OF QUASI-STELLAR OBJECTS IDENTIFIED BY

THEIR INFRARED EXCESS. Braccesi, A. (Laboratorio Nazionale di Radioastronomia, Bologna); Lynds, R.; Sandage, A. Astrophys. J., 152: L105-10(May 1968).

The criterion of infrared excess has been used to obtain a first candidate list of non-radio QSOs in a field centered at 15^h, +35°. Spectrographic data for objects with infrared excesses, chosen from a complete catalogue of blue objects to B ≅ 19.4 mag, show that fifteen objects, out of sixteen candidates observed, have emission lines characteristic of QSOs. Redshifts are given for fourteen of the objects. The surface density of QSOs in this field, when compared with the results of a survey to a brighter limiting magnitude for the PHL field 1^h36^m, +6°, shows that the number of objects continues to increase quite steeply going to fainter magnitudes. (auth)

29033 TWO NEW SEYFERT GALAXIES. Arp, H. C. (Mount Wilson Observatories, Pasadena. Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena); Khachikian, E. Y.; Lynds, C. R.; Weedman, D. W. Astrophys. J., 152: L103-4(May 1968).

Observations of blue galaxies found in an objective-prism survey by Markarian have revealed two objects that resemble closely the Seyfert galaxies. (auth)

29034 THE STRUCTURE OF THE OH SOURCE IN W3. Moran, J. M. (Massachusetts Inst. of Tech., Cambridge); Burke, B. F.; Barrett, A. H.; Rogers, A. E. E.; Ball, J. A.; Carter, J. C.; Cudaback, D. D. Astrophys. J., 152: L97-101(May 1968).

The source was studied with interferometers having minimum fringe spacings of 0.″044 and 0.″11, achieved with base lines of 845 and 3506 km. Antennas at NRAO, MIT, and Hot Creek were used. A map of the 1665 MHz emission complex is presented. (W.D.M.)

29035 OPTICAL OBSERVATIONS OF A PULSATING RADIO SOURCE. van den Bergh, Sidney (Univ. of Toronto). Astrophys. J., 152: L95(May 1968).

In a recent paper Ryle and Bailey (Nature, 217: 907(1968)) have identified one of the pulsating radio sources that has recently been discovered in Cambridge, with an eighteenth-magnitude blue star. A 48-inch Schmidt plate of this object was obtained during the night of July 5/6, 1967, on 103aE emulsion behind an RG1 filter. A blink comparison of this plate with a glass copy of the original Palomar Sky Survey red plate of this region, which was obtained on June 15/16, 1950, leads to the following conclusions: (1) The brightness of the image of the star which Ryle and Bailey identify with the radio source has not changed by more than 0.5 mag during the last seventeen years. (2) The proper motion of the star is smaller than 0.″1 per year. (Entire letter)

29036 INFRARED OBSERVATIONS OF η CARINAE. Neugebauer, G.; Westphal, J. A. (California Inst. of Tech., Pasadena). Astrophys. J., 152: L89-94(May 1968).

Eta Carinae is a nonstellar object less than 5 in. in diameter seen projected on a region of dense nebulosity. Spectroscopic observations, reviewed by Rodgers and Searle (1967) and Aller (1966) have shown strong emission lines superimposed on a smooth continuum. This continuum contributes about 60% of the visual energy and rises steeply into the infrared; no entirely satisfactory mechanism for producing this radiation has been proposed. In this Letter photometric data which extend the continuum observations to 1.65, 2.2, and 3.4 μ are presented. (auth)

29037 METAL ABUNDANCE IN A STARS. Henry, Richard C. (Princeton Univ., N. J.). Astrophys. J., 152: L87-8(May 1968).

It is shown that variations in Strömgren's $[m_1]$ index in A stars are due to abundance variations rather than to microturbulence and that the calcium abundance varies by a factor of 2 in A stars near the Sun; this calcium abundance shows no apparent correlation with stellar space motion. (auth)

29038 SOLAR X-RAY FLARES ON MAY 23, 1967. Van Allen, J. A. (Univ. of Iowa, Iowa City). Astrophys. J., 152: L85-6 (May 1968).

The absolute flux of soft x-rays (2 to 12 Å) from a sequence of three solar flares on May 23, 1967, is given as a function of time with a resolution of 163.6 sec. Maximum flux F(2 to 12 Å) = 0.65 erg cm^{-2} sec^{-1} occurred at 1846 U.T. This is believed to be the most intense solar x-ray flux that has been observed. (auth)

29039 COMPOSITION AND STRUCTURE OF THE CLOUDS OF VENUS. Lewis, John S. (Univ. of California, San Diego, La Jolla). Astrophys. J., 152: L79-83(May 1968).

There has been much recent interest in the structure and composition of the clouds of Venus, and of the role of these clouds in the interpretation of the microwave emissions of the planet. It is the purpose of this Letter to show that certain serious limitations on present theories of the clouds arise from a detailed consideration of the most recent spectroscopic data. (W.D.M.)

29040 γ-RAYS FROM DISCRETE RADIO SOURCES. Rengarajan, T. N. (Tata Inst. of Fundamental Research, Bombay). Proc. Indian Acad. Sci., Sect. A, 67: 61-70(Feb. 1968).

The fluxes of low-energy (~100 MeV) and high energy (~5×10^{12} eV) γ rays from intense radio sources were calculated under the hypothesis that radio electrons are continuously produced through nuclear collisions. The effect of expansion of the source which gives rise to a decrease in production rate with time was taken into account in these calculations. It was found that the fluxes expected from nuclear collision process are generally higher than the fluxes from other processes like bremsstrahlung and inverse Compton scattering by factors of 10 or more. While the calculated fluxes of γ rays of energy >100 MeV are less than the observed upper limits for all the processes, the fluxes calculated for nuclear collision processes for $E > 5 \times 10^{12}$ eV, exceed the experimental upper limits for Crab, Cas A, and the jet in Virgo A. More sensitive experiments should be able to decide whether the nuclear collision process is ruled out for low energies as well: in this respect Cas A seems to be the most promising source. (auth)

29041 PULSE STRUCTURE OF THE PULSATING RADIO SOURCE IN VULPECULA. Drake, F. D. (Arecibo Ionospheric Observatory, Puerto Rico). Science, 160: 417-19(Apr. 26, 1968).

The pulses from the pulsating radio source at right ascension 19 hours 19 minutes, declination +22° have the following characteristics: (i) they begin with a sharp leading edge; (ii) they terminate after 37 milliseconds; and (iii) they consist of three subpulses, the first of which is both the strongest and the best defined. (auth)

29042 OPTICAL PULSE OF A PERIODIC RADIO STAR. Duthie, J. G.; Sturch, C.; Hafner, E. M. (Univ. of Rochester, N. Y.). Science, 160: 415-16(Apr. 26, 1968).

The pulsating radio star reported by Hewish et al. (Nature, 217, 709 (1968)) was studied in the blue region of the optical spectrum and found to have a pulse amplitude less than 10% of the photon count expected for 18th magnitude. No upper limit to a sinusoidal oscillation less than or equal to a complete modulation can be set. (auth)

29043 BAND SPLITTING IN TYPE II SOLAR RADIO BURSTS. McLean, D. J. (CSIRO, Sydney). Proc. Astron. Soc. Aust., 1: 47-9(Nov. 1967). (RPP-1146).

A simple new explanation of band splitting in type-II bursts is presented, which was in fact suggested by a careful examination of some of the consequences of the better established aspects of the theory. (W.D.M.)

29044 PLANETARY MODULATION OF SOLAR ACTIVITY. Bigg, E. K.; Mulhall, P. S. (CSIRO, Sydney). Proc. Astron. Soc. Aust., 1: 53-4(Nov. 1967). (RPP-1139).

It has recently been shown that the planet Mercury exerts a small control on relative sunspot numbers, the degree of control depending on the positions of the other planets. This paper describes the results of extending the work to include all the planets. (W.D.M.)

29045 RESULTS OF THE SPECTROPHOTOMETRIC INVESTIGATION OF THE JUNE 25, 1960 CHROMOSPHERIC FLARE. PART I. Guseinov, R. E. Izv. Akad. Nauk Azerb. SSR, Ser. Fiz.-Tekh. Mat. Nauk, No. 3, 83-91(1966). (In Russian).

The flare (Ball 3) observed at the Czechslovak Academy's observatory during the period from 12: 08′ 55″ to 12: 59′ 50″ on June 25, 1960 at 24°N and 5°E of heliographic coordinates was studied on the basis of spectrograms covering various phases of the luminescence; 90 emission lines from the unexcited portions of the atmosphere were also examined. A large number of very high levels of the hydrogen atom were observed. It might be expected that in high-power flare, an inversion of the over-population of the high-energy levels may occur; it may be due to the recombination at the peak level of the hydrogen atoms. The phenomenon is similar to gas laser mechanisms and to the optical pumping encountered in synchrotron radiation. Results of the examination of the H, K, and helium lines are contained in Part II of the study. (TTT)

29046 RESULTS OF THE SPECTROPHOTOMETRIC INVESTIGATION OF THE AUGUST 21, 1959 CHROMOSPHERIC FLARE. PART II. Guseinov, R. E. Izv. Akad. Nauk Azerb. SSR, Ser. Fiz.-Tekh. Mat. Nauk, No. 3, 75-83(1966). (In Russian).

Following the first part of the study concerning the August 21, 1959 flare involving the H lines of the Balmer series, the results of the spectrophotometric examination of the H and K lines are presented. It was found that the optical density τ_0 was low, even in the center of the H_α line, indicating that the number of hydrogen atoms in the second quantum state was small and turbulence played an important role. The observed emission of the flare is

assumed to be due to the direct heating of the plasma or to shock waves. It was found that a linear correlation exists between the electron concentration and the electron temperature in all of the 3 studied points of the flare; this may be due to inhomogeneities of the solar atmosphere and to simultaneous changes in the electron temperature and concentration, resulting from the propagation of the shock wave causing the flare. (TTT)

29047 STABILITY OF THE SOLAR WIND. Jockers, Klaus (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Solar Phys., 3: 603-10(Apr. 1968).

The stability of the solar wind was studied in the case of spherical symmetry and constant temperature. It is shown that the stability problem must be formulated as a mixed initial and boundary-value problem in which are prescribed the perturbation values of velocity and density at an initial time and additionally the velocity perturbation at the base of the corona for all times. The solution is constructed by linear superposition of normal solutions, which contain the time only in an exponential factor. The stability problem becomes a singular eigenvalue problem for the amplitudes of the velocity and pressure perturbations, since additionally to the boundary condition at the base of the corona one must add the condition that the amplitudes behave regularly at the critical point. It is proved that only stable eigenvalues exist. (auth)

29048 RELATION BETWEEN THE SOLAR ACTIVITY CYCLE AND THE SOLAR TIDAL FORCE INDUCED BY THE PLANETS. Takahashi, Kozo (Radio Research Labs., Tokyo). Solar Phys., 3: 598-602(Apr. 1968).

The cross-correlation coefficient $\gamma(t)$ of the solar tidal force induced by the planets $f(x + t)$ with the sunspot number $g(x)$ during a period of 44 years is about -0.7 when t is about -2 years. This fact will be useful for predicting solar activity. The solar tidal force was calculated from 1928 to 1971 for every degree on the equatorial plane and every time every planet moved one degree. As the solar tidal force, the moving annual average by months of the square of the vertical tidal force on the Sun was used, and as the sunspot number the Zürich mean annual sunspot number was used. (auth)

29049 HOMOGENEOUS COSMOLOGICAL MODELS WITHOUT SHEAR. Banerji, S. (Univ. of Burdwan, India). Progr. Theor. Phys. (Kyoto), 39: 365-71(Feb. 1968).

Some general differential relations are presented on the dynamics of homogeneous rotating cosmological models with non-vanishing pressure. It appears from these that such models must in general be associated with shear if there be a linear relation between the pressure and the density except perhaps in the case $p = \rho/9$. (auth)

29050 DETECTION OF THE PULSED RADIO SOURCE CP 1919 AT 13 cm WAVELENGTH. Moffet, A. T.; Ekers, R. D. (California Inst. of Tech., Pasadena). Nature (London), 218: 227-9(Apr. 20, 1968).

From high-frequency measurements it is suggested that the spectrum of this pulsating radio source is extremely steep. (auth)(UK)

29051 FAR ULTRAVIOLET RADIATION FROM THE MILKY WAY. Kurt, V. G.; Dostovalov, S. B. (Sternberg State Astronomical Inst., Moscow). Nature (London), 218: 258(Apr. 20, 1968).

Observations made from Venera 4, launched on June 12, 1967, are discussed. These observations were made in two spectral intervals, the first including the hydrogen Lyman α line (λ1050 to 1340 Å) and the second over the interval λ1225 to 1340 Å. The photometer field of view crossed the Milky Way belt twice—near the constellations Cassiopeia and Cygnus in the northern hemisphere and near Lupus in the southern hemisphere. The maximal signal in the first spectral interval was about 25 times greater than that in the second interval. About half the signal in the second interval was caused by the cosmic-ray background, and the ratio of fluxes was ≈50. The high value of this ratio indicates that the radiation was observed in a narrow band, with intensity ~200R. The nature of the emission is briefly discussed, together with its most conspicuous details. It is stated that the hypothesis that the observed Lyman α emission originates in the peripheral parts of the solar system, where the solar wind is controlled by the galactic magnetic field, is attractive. (UK)

29052 QUASI-STELLAR OBJECTS WITH ABSORPTION LINES. McCrea, W. H. (Univ. of Sussex, Eng.). Nature (London), 218: 257-8(Apr. 20, 1968).

Observational results of Burbidge are discussed. It is assumed that the red shift (z) in the spectrum of a QSO is cosmological, and an immediate inference from the observations is the existence of many QSO's below the limits of optical or radio detection, the fraction below such limits increasing with z. Burbidge lists 19 QSO's with one or more absorption lines, and the proportion of absorption QSO's increases steeply with z. It is inferred that absorption QSO's are among the intrinsically brightest QSO's, since only such QSO's are detectable at large z; also that absorption QSO's form only a small percentage of all QSO's (probably not more than 1%). Another observational result is that there are objects classed as QSO's that show no detectable line spectrum. Almost all interpretations of the optical and radio observations lead to a model described as a compact nucleus producing the optical continuum radiation, surrounded by an envelope composed of zones producing the several features of the line and radio spectra. The author proposes that the part of the envelope responsible for the line spectrum has the form of a fairly well defined jet emerging radially from the compact nucleus. The QSO would also be pictured as part of a larger structure such as an elliptic galaxy. A jet is actually seen in 3C273, and there are indications of something similar in several other quasars; a jet is also seen in the radio galaxy Virgo A. The jet contemplated in the author's hypothesis would be an early stage of these observed jets. Both absorption and emission lines should be observed if the nucleus is seen through the jet, or emission lines only if seen obliquely; if the jet is not seen, no lines should be observed. Thus the three kinds of spectra would be explained very simply. The possibility that the radiation from quasars may be beamed is considered. This would mean that the energy requirement for a QSO could be much less than hitherto estimated. (UK)

29053 FURTHER OBSERVATIONS OF PULSATING RADIO SOURCES. Scott, P. F.; Collins, R. A. (Cambridge Univ., Eng.). Nature (London), 218: 230-2(Apr. 20, 1968).

It is stated that new observations make a binary star model unlikely and reveal complex frequency structure in individual pulses. (auth)(UK)

29054 MEASUREMENTS ON THE PERIOD OF THE PULSATING RADIO SOURCE AT 1919 + 21. Radhakrishnan, V.; Komesaroff, M. M.; Cooke, D. J. (CSIRO, Sydney). Nature (London), 218: 229-30(Apr. 20, 1968).

It is stated that the first observations from Australia of this pulsating radio source raise difficulties about the precise measurement of the period of oscillation. (auth)(UK)

29055 PULSED RADIO SOURCES. Burbidge, G. R. (Univ. of California, San Diego, La Jolla); Strittmatter, P. A. Nature (London), 218: 433-4(May 4, 1968).

The bursts of radio waves at decametric wavelengths emitted by Jupiter suggest a model for producing the signals from pulsating radio sources. This mechanism includes polarization of the signals and structure within the pulses. (auth)(UK)

29056 STRUCTURE OF THE GALACTIC MAGNETIC FIELD. Davies, R. D. (Univ. of Manchester, Eng.). Nature (London), 218: 435-7(May 4, 1968).

Faraday rotation measurements have shown that there is a basic order in the galactic magnetic field which can be fitted by simple models. The data also indicate the presence of irregularities in electron density or magnetic field with a scale of 10° or smaller. A galactic depolarization effect in emission from extragalactic sources requires a microscale in the magnetic field and electron density of 10 to 100 s of arc (0.05 to 0.5 pc) (auth)(UK)

29057 CHARACTER OF THE OPTICAL LUMINOSITY FLUCTUATIONS OF 3C 273. Gudzenko, L. I. (Lebedev Inst. of Physics, Moscow); Ozernoi, L. M.; Chertoprud, V. E. Nature (London), 218: 353(Apr. 27, 1968).

Comments are made on the note by Manwell and Simon (Nature 212: 1224 (1966)) in which it is stated there is confusion between the conventional terms "random" and "random process" and the concept of statistical independence. (UK)

29058 MEASUREMENTS OF THE PULSE SHAPE AND SPECTRA OF THE PULSATING RADIO SOURCES. Lyne, A. G.; Rickett, B. J. (Univ. of Manchester, Eng.). Nature (London), 218: 326-30(Apr. 27, 1968).

Simultaneous measurements of the pulsating radio signals at several frequencies were made with the 250-ft telescope at Jodrell Bank. Some of the pulses are double, suggesting two separated regions of emission. (auth)(UK)

29059 MEASUREMENT OF THE INTERSTELLAR MAGNETIC FIELD. Smith, F. G. (Univ. of Manchester, Eng.). Nature (London), 218: 325-6(Apr. 27, 1968).

The discovery that signals from pulsating radio sources are linearly polarized means that interstellar magnetic fields in the local part of the Galaxy can be measured. (auth)(UK)

29060 WHEN WERE GALAXIES AND GALAXY CLUSTERS FORMED? Silk, J. (Harvard Coll. Observatory, Cambridge, Mass.). Nature (London), 218: 453-4(May 4, 1968).

It is stated that a recent theoretical treatment of the dissipative effects resulting from radiative diffusion on inhomogeneities during expansion from the primordial fireball phase of the Universe yielded a critical size for the fluctuations, below which radiative smoothing was dominant over a time short compared with the cosmic expansion time. This enables anisotropy measurements to be used to make quantitative statements about the possible epochs of galaxy formation, when the fluctuations first became gravitationally bound. This theme is developed in the present communication. (UK)

29061 SURVEY OF THEORIES RELATING TO THE ORIGIN OF THE SOLAR SYSTEM. Williams, J. P.; Cremin, A. W. Quart. J. Roy. Astron. Soc., 9: 40-62(Mar. 1968).

The theories that have been proposed are discussed according to the following classifying system. (1) Theories that regard the origin and formation of the planets as being essentially related to the formation of the Sun. The two formation processes must either take place concurrently or consecutively. (2) Theories that regard the formation of the planets as being independent of the formation process for the Sun, the planets forming after the Sun had become a normal star. This second category can be subdivided into two subcategories: 2(a) Where the material for the formation of the planets is extracted either from the Sun or from another star. 2(b) Where the material is acquired from interstellar space. The main theories in all these categories are summarized. (UK)

29062 NEW DETERMINATION OF THE POSITION OF JUPITER'S MAGNETIC AXIS. Conway, R. G.; Kronberg, P. P. (Manchester Univ., Eng.). Planet. Space Sci., 16: 445-8(Apr. 1968).

An interferometric technique was used to observe Jupiter at λ21 cm at Jodrell Bank. The observations provide a value for the inclination and longitude of Jupiter's magnetic axis determined independently of previous methods. The source diameter parallel to Jupiter's magnetic axis, as well as the net flux, are also deduced. None of these quantities appears to have varied significantly over the period 1960–1965. (auth)(UK)

29063 ABSOLUTE WAVELENGTHS OF FRAUNHOFER LINES: CONVECTIVE MOTIONS IN THE SOLAR PHOTOSPHERE AND THE GRAVITATIONAL RED SHIFT. Lambert, D. L.; Mallia, E. A. (University Observatory, Oxford). Solar Phys., 3: 499-504(Apr. 1968).

Absolute wavelengths for Fraunhofer lines are compared with laboratory measurements for several atomic and molecular spectra. The wavelength differences are shown to be consistent with the proposal that the deeper layers of the photosphere are in convective motion: $v_c \simeq 3$ km/sec for $\log \tau_0 > -1.0$. Convective motions in the outer layers ($\log \tau_0 < -1.0$) are shown to be very small. Wavelength shifts of Fraunhofer lines formed in these outer layers are in good quantitative agreement with the predictions of the general theory of relativity. (auth)

29064 BEHAVIOR OF A CLOCK MOVING IN A CENTRALLY SYMMETRIC GRAVITATIONAL FIELD. Polishchuk, R. F. (Shternberg Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.), 11: 886-91(Mar.-Apr. 1968).

Translated from Astron. Zh., 44: 1104-13(Sept.-Oct. 1967).

To determine the proper time of a test particle, the equations of free and restricted plane motion of the particle in a Schwarzschild field are integrated in the general case, using a standard clock. The clock paradox is considered for the following special cases: free quasielliptic, circular (a satellite), radial elliptic, parabolic, and hyperbolic free motion, and motion subject to radial forces. In particular, it is shown that a motion receding to an unbounded distance is possible such that, contrary to special relativity theory, the proper time of the moving object will exceed the proper time of an object remaining at the point of departure. (auth)

29065 BINARY NATURE OF Z ANDROMEDAE. Boyarchuk, A. A. (Crimean Astrophysical Observatory, Moscow). Sov. Astron. AJ (Engl. Transl.), 11: 818-27(Mar.-Apr. 1968).

Translated from Astron. Zh., 44: 1016-27(Sept.-Oct. 1967).

Observational data on Z And published elsewhere were analyzed in terms of the hypothesis that the star is binary. The observations can be explained if Z And consists of a cool M2 III giant of constant brightness and a hot dwarf ($T \approx 10^5$°K, $R \approx 0.5R_\odot$) varying at times by as much as 6^m. The two stars are surrounded by a dense nebula ($n_e \approx 10^7$ cm^{-3}) in which emission lines of high-excitation ions are formed. Emission lines of singly ionized metals are formed in the extended atmosphere of the giant. (auth)

29066 CONVECTIVE INSTABILITY AND OVERSTABILITY IN THE SUNSPOT UMBRA. Saito, Mamoru; Kato, Shoji (Tokyo Univ.). Solar Phys., 3: 531-42(Apr. 1968).

Convective instability and overstability of a plane-parallel medium in the presence of a uniform vertical magnetic field is studied. The effect of penetration of disturbances into sub-adiabatically stratified semi-infinite upper and lower layers and the effect of thermal damping of disturbances introduced by the compressibility of the medium are taken into account. If the degree of super-adiabaticity in temperature stratification in the middle layer is relatively large compared with that of sub-adiabaticity in the upper and lower layers, the range of physical conditions in which overstable convection occurs is very narrow. However, if it is not the case the range is rather wide. In the normal sunspot umbra, only disturbances with selected sizes in vertical dimension will be able to become overstable. The overstable convection might be a cause of some dynamical features (such as dots) in the sunspot umbra, but will not be the main contributor for transporting mechanical energy in the sunspot region. (auth)

29067 COSMOLOGICAL MODELS AND SPATIAL-HOMOGENEITY CRITERIA. Grishchuk, L. P. (Shternberg Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.), 11: 881-5(Mar.-Apr. 1968).

Translated from Astron. Zh., 44: 1097-1103(Sept.-Oct. 1967).

The difference between the two presently known criteria for spatial homogeneity is elucidated. All the metrics satisfying one of these criteria are determined; the metrics satisfying the other criterion are already known. A comparison is made between these metrics; it is shown that they all satisfy a certain generalized spatial-homogeneity criterion. (auth)

29068 DECAMETER SPECTRUM OF THE DISCRETE SOURCES CASSIOPEIA A AND CYGNUS A. Belikovich, V. V.; Benediktov, E. A.; Korobkov, Yu. S. (Gorky State Univ., USSR). Sov. Astron. AJ (Engl. Transl.), 11: 789-91(Mar.-Apr. 1968).

Translated from Astron. Zh., 44: 981-3(Sept.-Oct. 1967).

The intensities of the discrete sources Cas A and Cyg A were measured at several fixed frequencies in the decameter wavelength range. The measurements were obtained with interferometers comprised of antennas with directional patterns extending to about 25° · 25° at half-power level. The flux density of Cas A was also determined independently at 8.9 MHz by means of a broadside antenna array consisting of 120 wave dipoles. (auth)

29069 DISCRETE RADIO-FREQUENCY SPECTRUM OF ATOMIC HYDROGEN. Minaeva, L. A.; Sobel'man, I. I.; Sorochenko, R. L. (Lebedev Inst. of Physics, Moscow). Sov. Astron. AJ (Engl. Transl.), 11: 800-4(Mar.-Apr. 1968).

Translated from Astron. Zh., 44: 995-1000(Sept.-Oct. 1967).

A theoretical discussion is given of several problems regarding the discrete radio-frequency spectrum of atomic hydrogen. The values computed for line widths due to electron broadening in $n \rightarrow n-1$ transitions are compared with the results of radioastronomy observations. (auth)

29070 EMISSION GRADIENTS IN THE CONTINUUM AT THE SUN'S LIMB. Hiei, Eijiro (High Altitude Observatory, Boulder, Colo.); Faller, James E. Solar Phys., 3: 513-22(Apr. 1968).

The intensity variation at the Sun's limb was studied in order to derive the gradient of the temperature in the low chromosphere. Eclipse observations show that in the continuum the height gradients of the total intensity vary systematically with wavelength; the observed gradient in the red is found to be steeper than in the blue. This wavelength dependence of the gradients is explained by the temperature increase in the low chromosphere. (auth)

29071 ELECTRICAL CONDUCTIVITY IN SUNSPOT REGIONS. Oster, Ludwig (Joint Inst. for Laboratory Astrophysics, Boulder, Colo.). Solar Phys., 3: 543-56(Apr. 1968).

The basis of conductivity calculations in the presence of magnetic fields is reviewed, covering for a solar-type plasma the full temperature range between complete ionization of hydrogen and H_2-molecule formation. It is shown that both the general conductivity theory and knowledge of momentum transfer cross sections are now developed to the point where the resulting coefficients should be accurate to about 50% and better. This removes an often-cited difficulty in model calculations for sunspots. For one specific case, a comparison is carried out with previous less accurate determinations of the conductivity. (auth)

29072 EMISSION OF FeXV IN CORONAL CONDITIONS. Bely, O. (Observatoire de Nice); Blaha, M. Solar Phys., 3: 563-77(Apr. 1968).

Relative intensities of 12 spectral lines of Fe xv were calcu-

lated for various values of N_e and T_e. Nine levels of the ion were taken into account and all excitation and de-excitation processes were considered. The results are given. (auth)

29073 EXCITATION OF SPECTRUM LINES IN NEBULAE BY RESONANT SCATTERING OF RADIATION FROM THE CENTRAL STARS. Seaton, M. J. (University Coll., London). Mon. Notic. Roy. Astron. Soc., 139: 129-34(1968).

The spectra of planetary nebulae contain weak permitted lines of ions of oxygen, carbon, and various other elements. It is shown that ion abundances, obtained on assuming these lines to be excited by recombination, are an order of magnitude too large. An alternative mechanism is therefore proposed: that excitation is by absorption of stellar radiation in spectrum lines. Approximate calculations show that this mechanism should be capable of explaining the observed line intensities. An improved estimate is obtained for the oxygen abundance in NGC 7027, $N(O)/N(H) = 2.3 \times 10^{-4}$. (auth) (UK)

29074 FORBIDDEN LINES OF OI IN THE PHOTOSPHERIC SPECTRUM. Mallia, E. A. (University Observatory, Oxford). Solar Phys., 3: 505-9(Apr. 1968).

Solar wavelengths of the O I lines were measured at the center of the disk by using neighboring strong lines as standards. The gravitational red shift was substracted from the solar wavelengths, after account had been taken of a calculated 5-mÅ blue shift arising from convection in the photosphere. The resultant wavelengths are shown. There is good agreement between sets of terrestrial measurements and the present solar values. The wavelength for λ 6363 is much closer to the airglow value than to the laboratory value. (W.D.M.)

29075 HIGH RESOLUTION RADIO OBSERVATIONS OF THE PLANET JUPITER. Branson, N. J. B. A. (Cambridge Univ., Eng.). Mon. Notic. Roy. Astron. Soc., 139: 155-62(1968).

The Cambridge one-mile radio telescope was used to obtain maps of the radio emission from the planet Jupiter for different values of the central meridian longitude of the planet. The observations were made at wavelengths of 75 cm and 21 cm. The disc temperature at $\lambda = 21$ cm was found to be (250 ± 40)°K, and a model was derived of the electron density distribution within the Jovian radiation belts. (auth) (UK)

29076 INFRARED SPECTRUM OF ALGOL. Glushneva, I. N.; Esipov, V. F. (Shternberg Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.), 11: 828-33(Mar.-Apr. 1968).
Translated from Astron. Zh., 44: 1028-35(Sept.-Oct. 1967).

The continuum of Algol in the range $\lambda\lambda$ 6700 to 11,000 Å was investigated. The observed spectral energy distribution in this range at primary minimum agrees well with the theoretical distribution if the dark companion is considered a type K0 star. Spectrograms of Algol in the range $\lambda\lambda$ 10,570 to 10,920 Å were obtained at various phases. Of the 33 absorption lines detected, 30 were identified; their equivalent widths and residual intensities were determined. For most of the lines the equivalent width increases at primary minimum, so that the lines belong to the third body, Algol C, or to the dark companion, Algol B. For some lines the equivalent width either shows no appreciable variations at primary minimum, or decreases somewhat; these lines apparently belong to the primary star, Algol A. (auth)

29077 INTERPRETATION OF THE DIP IN THE SPECTRUM OF MILLIMETER SOLAR RADIO EMISSION. Kaplan, S. A.; Tsytovich, V. N. (Gorky Univ., USSR. Lebedev Inst. of Physics, Moscow). Sov. Astron. AJ (Engl. Transl.), 11: 834-6(Mar.-Apr. 1968).
Translated from Astron. Zh., 44: 1036-9(Sept.-Oct. 1967).

The suggestion is made that the dip at $\lambda = 6$ mm in the spectrum of solar radio emission results from scattering of radio waves by plasma-turbulence waves in the chromospheric layer where intensive dissipation of large-scale turbulence occurs. Small-scale plasma turbulence is presumably excited there. (auth)

29078 INTERGALACTIC MEDIUM ACCORDING TO RADIO OBSERVATIONS. Pariiskii, Yu. N. (Central Astronomical Observatory, Pulkovo, USSR). Sov. Astron. AJ (Engl. Transl.), 11: 782-4(Mar.-Apr. 1968).
Translated from Astron. Zh., 44: 971-4(Sept.-Oct. 1967).

The absence of a Faraday effect in the intergalactic medium even for very remote sources with $z = 1$ (3C 286), and the lack of any "intergalactic wind" effect on the relative orientation of the components of double radio galaxies and the corresponding optical objects, yield new upper bounds on the density and the magnetic field in intergalactic space, calling for a value $q_0 \ll 1$. (auth)

29079 IONIZATION AND HEATING OF THE INTERSTELLAR GAS BY SUBCOSMIC RAYS, AND THE FORMATION OF CLOUDS. Pikel'ner, S. B. (Shternberg Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.), 11: 737-48(Mar.-Apr. 1968).
Translated from Astron. Zh., 44: 915-29(Sept.-Oct. 1967).

The Faraday rotation of radio emission demonstrates that $\langle N_e \rangle \approx 10^{-2}$ cm^{-3} in the spiral arms. The relation between the Faraday rotation and the depolarization of the arms' own radio emission shows that the rotation is produced inside the arms. H II regions are not responsible, since the rotation is distributed regularly over the sky. It follows that the hydrogen is partially ionized by subcosmic rays with an effective energy of 25 MeV and an energy density of about 1 eV/cm^3. These rays also serve to heat the gas through ionization of H and He and interaction with plasma. The density dependence of the temperature and ionization is calculated. The bulk of the gas has $N_H \approx 0.1$ cm^{-3} and $T \approx 5000$ to 6000°K. Clouds with N_H from 1 to 4 cm^{-3} will have T from 150 to 80°K. The pressure is maximal for T = 5000°K, so that gas with $N_H > 0.1$ cm^{-3} will contract until the cloud density is reached. Since the calculations agree with the observations, several conclusions may be drawn. The abundance of H_2 molecules in gas of density $N_H \leq 2$ cm^{-3} should be less than the H abundance. Subcosmic rays will vaporize interstellar dust; this process will control the mean grain size, which is related to the gas density. The relatively high value of N_e calls for a revision in the degree of ionization of the elements in the interstellar gas, and diminishes the estimated mass of the clouds. The clouds are supported by a magnetic field, and will fluctuate about an equilibrium position. If the mass of a cloud is sufficiently great it will sink almost to the galactic plane, and the gas moving along the lines of force will fall into the "hole" that develops, increasing the mass of the cloud until star formation sets in. Hot rarefied gas will explain the radio temperature in the 21-cm line. Low-frequency radio emission is absorbed in cool H I clouds, where $N_e \approx 0.03$ cm^{-3}. Outside the spiral arms $N_H < 0.1$ cm^{-3}; there will be no thermal instability and no clouds. In radio galaxies the limit of instability (T ≈ 6000°K) may correspond to $N_H > 1$ cm^{-3}, so that dense clouds should form there first, while if the density is lower than the critical value the gas will be stable and clouds will not form. (auth)

29080 MEASUREMENT OF THE SOLAR H AND K PROFILES. White, O. R. (Sacramento Peak Observatory, Calif.); Suemoto, Z. Solar Phys., 3: 523-30(Apr. 1968).

A new series of photometric observations of the H and K lines were obtained at Sacramento Peak Observatory in 1964 and 1965. In both the observations and the data reduction special attention was given to obtaining a suitable average over the solar fine structure and to defining a proper reference continuum. The results are that the central intensities of H and K are the same and equal to 4.2% of the continuum. The limb-darkening curves at the line centers are also the same for both lines. (auth)

29081 MEAN TEMPERATURE OF THE SOLAR CORONA. Nikol'skii, G. M. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Sov. Astron. AJ (Engl. Transl.), 11: 837-8(Mar.-Apr. 1968).
Translated from Astron. Zh., 44: 1040-2(Sept.-Oct. 1967).

The mean temperature of the solar corona determined from a theory taking dielectronic recombination into account is $T_0 \approx (2.5 \text{ to } 3) \times 10^6$°K, a value twice as high as that previously accepted (1.5×10^6°K). Several facts contradict the higher value of T_0. Evidently dielectronic recombination plays no part in the ionization balance of the corona. (auth)

29082 NATURE OF THE X-RAY SOURCE Sco X-1. Shklovskii, I. S. (Shternberg Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.), 11: 749-55(Mar.-Apr. 1968).
Translated from Astron. Zh., 44: 930-8(Sept.-Oct. 1967).

It is shown that the optical radiation of the object recently identified with the x-ray source Sco X-1 cannot represent a low-frequency extension of the radiation from the optically thin layer of hot plasma which is apparently responsible for the x rays of this source. It is calculated that the hot plasma should be opaque in the optical frequency range, with its radiation following the Rayleigh–Jeans formula. The condition that this radiant flux be no greater than the flux of optical radiation from the object identified with Sco X-1 yields upper and lower bounds on the size of the x-ray source of about 10^9 (r/200) and 10^8 (r/200) cm, respectively, where r is the distance to the source in parsecs. A "stratified" model of the source is proposed, with the temperature rising from ≈10^6°K to ≈5×10^8°K toward its center. It might be possible to observe the emission lines of Fe XXV and Fe XXVI in the x-ray spectrum of Sco X-1, with a substantial gravitational red shift. Evidence is given that the source is a neutron star forming a comparatively massive component of a close binary system. A stream of gas flowing out of the second component is permanently incident on the neutron star. An analysis is made of the physical conditions in the gas stream, where the H, He, N III,

and C III emission lines originate. $N_e \approx 10^{13}$ cm^{-3} there, and the rate of mass flow through the stream is $\approx 10^{16}$-10^{17} g/sec, enough to maintain the x-ray energy at the level observed. It is suggested that the optical object accompanying the x-ray source might be a cool dwarf star, with half of its surface heated by a strong flux of hard x rays from the source. (auth)

29083 NEW SPECTROSCOPIC BINARY STAR, HD 3950. Vitrichenko, E. A. (Crimean Astrophysical Observatory, USSR). Sov. Astron. AJ (Engl. Transl.), 11: 898-9(Mar.-Apr. 1968).

Translated from Astron. Zh., 44: 1121-2(Sept.-Oct. 1967).

The star HD 3950, which is included in a list of anomalously fast OB stars was found to be a spectroscopic binary, and its properties were investigated. (auth)

29084 OBSERVATION AND INTERPRETATION OF SOME REGULARITIES OF SUNSPOT DEVELOPMENT. Ikhsanov, R. N. (Main Astronomical Observatory, Pulkovo, USSR). Sov. Astron. AJ (Engl. Transl.), 11: 843-51(Mar.-Apr. 1968).

Translated from Astron. Zh., 44: 1048-59(Sept.-Oct. 1967).

An attempt is made at a further explanation of some observed general regularities of sunspot development through the comparative study of four characteristics: time variations in spot magnetic-field strength and area, motion of spots in the group, and changes in structure. It is demonstrated that if the observable $H_m - S$ relation is explained as the result of the pseudo-dipole nature of the field in the outer portions of a spot it becomes possible to interpret many features of spot development. The cause of the pseudo-dipole nature of the field outside the umbra in the photosphere is stated. The observed variation in H_m as a spot develops from birth to maximum is due to the variation in the vertical field component as a magnetic rope rises to the Sun's surface. The development of spot area depends not only as the largest value of H_m but also, and especially, on spot structure, i.e., on the number and size of umbrae. This may explain the varied nature of spot area growth. The existence of a critical range of spot area ($S \approx 160$ millionths of the visible hemisphere) in the decay stage can be interpreted as the value dividing spots into short-lived and recurrent categories. Structure and environment must be taken into account in this connection. (auth)

29085 OBSERVATIONS OF A BRIGHT FILAMENT IN THE SOUTHERN PART OF NGC 7000 WITH A FABRY–PEROT ETALON. Artamonov, B. P.; Shcheglov, P. V. (Shternberg Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.), 11: 892-4(Mar.-Apr. 1968).

Translated from Astron. Zh., 44: 1114-16(Sept.-Oct. 1967).

The filaments in the southern part of the nebula NGC 7000 were observed with a Fabry–Perot étalon. The Hα line profiles in the filaments are broadened to 36 to 55 km/sec, and apparently belong to gas condensations moving relative to one another at a velocity of about 20 to 30 km/sec. (auth)

29086 PHYSICAL PARAMETERS OF PLANETARY NEBULAE. Arkhipova, V. P.; Kostyakova, E. B. (Shternberg Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.), 11: 812-17 (Mar.-Apr. 1968).

Translated from Astron. Zh., 44: 1009-15(Sept.-Oct. 1967).

The physical parameters T_*, n_e, and T_e were determined for 65 planetary nebulae from a homogeneous set of observational material. A marked correlation is revealed of the parameters T_e and n_e with the temperature of the nucleus as derived from the hydrogen lines by the Zanstra method. The results are presented. (auth)

29087 POSSIBILITY OF A LONG LIFETIME FOR INTERGALACTIC ARMS. Zasov, A. V. (Shternberg Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.), 11: 785-8 (Mar.-Apr. 1968).

Translated from Astron. Zh., 44: 975-80(Sept.-Oct. 1967).

The physical properties of the long intergalactic arms connected to the so-called interacting galaxies are considered. The suggestion that the lifetime of these formations is comparable to the lifetime of the galaxies is substantiated. It is proposed that a continuing formation of young stars from material accreted from an intergalactic medium of density $\approx 10^{-27}$ g/cm^3 takes place in the arms. (auth)

29088 PROBLEM OF HELIUM EMISSION IN THE CHROMOSPHERE. Nikol'skaya, K. I. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Sov. Astron. AJ (Engl. Transl.), 11: 839-42(Mar.-Apr. 1968).

Translated from Astron. Zh., 44: 1043-7(Sept.-Oct. 1967).

The hypothesis of low-temperature helium emission in the chromosphere is shown not to conflict with the observations. The good agreement between the nonthermal velocities determined by various investigators from the metal and hydrogen lines and the velocities of nonthermal motion computed from the He I lines (D_3 and 3889 Å) under the assumption $T_k = 6000$°K supports the claim that the "hydrogen," "metal," and "helium" regions are identical. There is no need to assume the presence of "cool" and "warm" elements in the chromosphere, since helium, the metals and hydrogen can radiate in the same regions having $T_k < 10{,}000$°K. The velocities of nonthermal motion in the chromosphere are very large and increase rapidly with height. A value $v_t \approx 20$ km/sec is already reached at a height h = 6000 to 7000 km above the limb. The nonthermal motions in the chromosphere are apparently macroscopic in character, representing the motion of individual condensations. (auth)

29089 RADIO LUMINOSITY FUNCTION OF GALAXIES. Sholomitskii, G. B. (Shternberg Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.), 11: 756-66(Mar.-Apr. 1968).

Translated from Astron. Zh., 44: 939-51(Sept.-Oct. 1967).

If the radio luminosity function follows a power law of the form $dn = aP^{-\Gamma}dP$, then beginning with a certain critical value of the radio flux density, the number of objects forming a complete list of sources with flux > F increases with increasing red shift according to the law $N(F,z) \propto F^{1-\Gamma} z^{3-2\Gamma}$ – const for $\Gamma < 3/2$. When N(F,z) is used to determine the parameters of the power luminosity function for radio galaxies and normal galaxies independently, the functions are found to be given by practically the same formula, $dn = 1.3 \cdot 10^{23} p^{-2.18} dP$ Mpc^{-3} at 178-MHz frequency. Since the observed value $\Gamma = 2.18$ falls in the range $2 < \Gamma < 3/2$, the specific luminosity (per Mpc^3) and the brightness of the background ratio emission of the metagalaxy are determined by the lower limit of the luminosity function, while statistical N(F) counts are determined by the upper limit. The luminosity per Mpc^3, bounded above by the total concentration of galaxies, depends weakly on that concentration ($j_0 \propto n_{gal}^{0.18}$), and despite the large uncertainty in the value of n_{gal}, the error in the computed j_0 can hardly exceed 50%. The corresponding brightness temperature of the background due to galaxies at 178-MHz frequency is 18 to 40°K, if the deceleration parameter $q_0 = 0 - 1/2$ and evolution is absent. The distribution of radio galaxies in the volume–luminosity plane is wholly determined by observational selection and the luminosity function, with no evolutionary hypotheses of any kind. (auth)

29090 RADIO-SOURCE SPECTRA AT METER WAVELENGTHS. Artyukh, V. S.; Vitkevich, V. V.; Dagkesamanskii, R. D. (Lebedev Inst. of Physics, Moscow). Sov. Astron. AJ (Engl. Transl.), 11: 792-9(Mar.-Apr. 1968).

Translated from Astron. Zh., 44: 984-94(Sept.-Oct. 1967).

The flux densities of 146 radio sources from the 3C catalogue were measured, 119 at 86 MHz and 27 at 38 MHz, using the wide-range Mills cross radio telescope at the Lebedev Physics Institute (DKR–1000). The observation and calibration procedures are described. Spectral indices α_1 in the 1.7 to 3.5-m range were found for 108 radio sources. The spectral-index distribution of these sources is compared with the α_1 spectral-index distribution found by Kellermann. The spectra of some interesting sources are discussed in further detail. (auth)

29091 RADIO EMISSION OF THE $n_{105} \rightarrow n_{104}$ EXCITED-HYDROGEN LINE IN SEVERAL NORTHERN NEBULAE. Gudnov, V. M.; Sorochenko, R. L. (Lebedev Inst. of Physics, Moscow). Sov. Astron. AJ (Engl. Transl.), 11: 805-11(Mar.-Apr. 1968).

Translated from Astron. Zh., 44: 1001-8(Sept.-Oct. 1967).

The intensity and width of the $n_{105} \rightarrow n_{104}$ line of excited hydrogen were measured for the eight brightest emission nebulae. The line/continuum intensity ratio ranges from 4 to 7% for the different nebulae; the line width is 500 to 750 kHz. The radial velocities of the nebulae exhibit a good correlation with the velocities of neighboring neutral-hydrogen clouds. (auth)

29092 REDSHIFT–ABSOLUTE MAGNITUDE RELATION OF QUASI-STELLAR SOURCES. Barnothy, J. M.; Barnothy, M. F. (Univ. of Illinois, Chicago). Sov. Astron. AJ (Engl. Transl.), 11: 895-7(Mar.-Apr. 1968).

Translated from Astron. Zh., 44: 1117-20(Sept.-Oct. 1967).

The correlation between the absolute value and red shift of quasars for various models of the Universe is considered. A small correlation coefficient can be considered as the correctness measure of one or another model. The probability of the fact that the correlation coefficient differs accidentally from zero (which is also a probability of the model), is calculated. (auth)

29093 SOLAR GRANULATION SPECTROGRAM. Kirk, J. G.; Livingston, W. (Kitt Peak National Observatory, Tucson, Ariz.). Solar Phys., 3: 510-12(Apr. 1968).

On Aug. 25, 1965 spectrograms centered on the line Ba II λ 5854 were obtained with the McMath Solar Telescope of Kitt Peak under

conditions of very good seeing so that the granulation velocity field was clearly revealed. These spectrograms were obtained at the center of the disk in the fifth order of the grating, yielding a dispersion of 9.73 mm/Å. (W.D.M.)

29094 SPECTROPHOTOMETRY OF THE JET IN NGC 4486. Pronik, V. I.; Pronik, I. I.; Chuvaev, K. K. (Crimean Astrophysical Observatory, Moscow). Sov. Astron. AJ (Engl. Transl.), 11: 777-81(Mar.-Apr. 1968).

Translated from Astron. Zh., 44: 965-70(Sept.-Oct. 1967).

The relative energy distribution in the spectrum of the jet in NGC 4486 over the range λλ 3730 to 6600 Å is derived from spectrograms and direct photographs with six filters (λλ 3730, 4550, 4870, 5290, 6090, 6620 Å). The spectrum is characterized by a sharp radiation maximum near $\lambda \approx 4200$ Å. The flux in the range λλ 4800 to 6600 Å follows a frequency distribution $F_\nu \sim \nu^{-1.5}$. The integrated magnitude of the jet in the photographic spectral region, obtained as the mean of determinations by several authors, is $14^m.9 \pm 0^m.3$. (auth)

29095 SPECTROPHOTOMETRIC STUDY OF SEYFERT-GALAXY NUCLEI. Dibai, E. A.; Pronik, V. I. (Shternberg Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.), 11: 767-76(Mar.-Apr. 1968).

Translated from Astron. Zh., 44: 952-64(Sept.-Oct. 1967).

The results are reported of a spectrophotometric study of the nuclei of six Seyfert galaxies: NGC 1068, 1275, 3227, 3516, 4051, and 7469. Spectrum analysis indicates that two subsystems of gas are present in the nuclei: a denser component ($n_e \approx 10^6 - 10^7$ cm^{-3}) with a large velocity dispersion (several thousand km/sec), and a less dense component ($n_e \approx 10^3 - 10^4$ cm^{-3}) with a small velocity dispersion (several hundred km/sec). A consideration of the spatial structure of the two-component gaseous formation shows that the most probable arrangement would have dense and high-velocity gas elements with a typical size from a fraction of a parsec to several parsecs in the inner parts of the nucleus, while the outer parts (tens or hundreds of parsecs) would form a slowly expanding nonuniform envelope of low density. The sharp distinction in the properties of the two subsystems apparently results from their formation through successive discrete eruptions in the central parts of the nucleus. The problem of the ionization of the gas in Seyfert-galaxy nuclei is considered. An "optical luminosity–volume" diagram is prepared for 12 objects, including radio galaxies and quasistellar sources as well as Seyfert galaxies. The diagram exhibits two sequences corresponding to different values of the density. The linearity of these sequences indicates that the luminosity of the gas per unit volume is approximately constant. Hence the processes responsible for the radiation of the gas in the envelopes of quasistellar sources, radio galaxies, and Seyfert galaxies are all physically similar. (auth)

29096 STELLAR SPECTRA IN THE CLUSTER MESSIER 7. Buscombe, W.; Kennedy, P. M. (Australian National Univ., Canberra). Mon. Notic. Roy. Astron. Soc., 139: 215-20(1968).

MK classifications are given for 20 member stars in the cluster M7 = NGC 6475. Equivalent widths of Hγ and Hδ were measured on direct-intensity tracings from spectrograms of moderate dispersion. By the use of Petrie's revised calibration a mean distance of 165 parsecs from the Sun was determined. The distance derived from main-sequence fitting using broad-band photometry, however, is 250 parsecs. The A-type stars in M7 are rotating more slowly than stars in the Pleiades studied by Petrie, and the $M_V - H\gamma$ calibration may require refinement for this and other evolutionary effects. The mean radial velocity from 70 spectrograms is −8 km/s, which differs by 5 km/s from the value for members of the Scorpio–Centaurus association near the same galactic longitude, and the proper motion differs even more markedly. (auth) (UK)

29097 STUDY OF THE GREEN TiO BAND IN THE SUNSPOT SPECTRUM. Makita, Mitsugu (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Solar Phys., 3: 557-62(Apr. 1968).

The equivalent widths of the TiO lines in the α system were measured on a high-dispersion (11 mm/Å) spectrogram of a large sunspot. The lines were so weak that the measurement was made by methods giving maximum and minimum equivalent widths, depending on the adopted continuum. The rotational temperature obtained in this way was about 3000°K. The result is unaffected by stray light because there are no TiO lines in the undisturbed spectrum. The calculation of equivalent widths using several sunspot models (all of which can satisfy the observed data) shows that the logarithmic optical depth at the effective layer of molecular line formation is about −1.6. (auth)

29098 SOME GENERAL PROPERTIES OF HELMETED CORONAL STRUCTURES. Pneuman, G. W. (High Altitude Observatory, Boulder, Colo.). Solar Phys., 3: 578-97(Apr. 1968).

A simplified analysis of helmeted coronal structures is carried out and some of the gross properties of such structures discussed. It is found that the magnetically closed region can have but a limited extension into the corona. For temperatures in excess of 1.5×10^6°K, the maximum height above the limb is about 1.6 $R_\odot$. The maximum possible extension of the helmet from the solar center is exactly one-half the distance to the critical point (where the flow velocity passes through the speed of sound). For this reason, a helmet streamer, at least out to a few solar radii, is essentially a magnetostatic structure—the flow adjacent to the helmet having little effect upon its properties. For given base dimensions, there is a maximum temperature for which a helmet streamer can exist—giving an indication of why such streamers do not appear over young active regions. If the temperature in the helmet and in the streaming region are approximately the same, the helmet height, helmet shape, external flow velocity, and rate of outward decline in the magnetic field are shown to be much more dependent upon the photospheric field distribution than upon the field strength. The density enhancement, however, is a strong function of the field strength. This enhancement is preserved out to the top of the helmet with both the density inside and outside decreasing approximately as predicted by hydrostatic equilibrium. The possible existence of both domed helmets and cusped helmets is demonstrated with the former existing at lower temperatures and the latter at higher temperatures. Cusped helmets occur, however, over a relatively narrow temperature range and are, hence, expected to be less common. The expansion velocity outside the helmet is higher than that predicted by radial flow but increases outward much more slowly. The magnetic field decreases outward proportionally to the squre root of the density and inversely proportionally to the velocity—bearing, in general, no relation to a potential field since the rate of decline in field strength is determined by the temperature. (auth)

29099 TEMPERATURES, METAL ABUNDANCE, AND MASS OF THE DISC CEPHEID κ PAVONIS. Rodgers, A. W.; Bell, R. A. (Australian National Univ., Canberra). Mon. Notic. Roy. Astron. Soc., 139: 175-87(1968).

Balmer line and infrared continuum photometry, together with curve of growth analyses were used to determine the temperatures of the disc Cepheid κ Pavonis. The temperature amplitude is 0.16 ± 0.02 in θ and the median temperature lies between the limits $\bar{\theta}_{eff} = 0.86$ to 0.91. [Fe/H] was found to be between 0.0 and −0.4. Elements produced by slow neutron capture were confirmed to be deficient relative to e-process elements by a factor 8. On the rising branch of the light curve an excess blue radiation (longward of the Balmer jump) was observed, which is not theoretically explained by gravity effects on the continuous energy distribution. Application of a period luminosity relation for globular cluster Cepheids leads to a mass of 0.4 to 0.65 $M_\odot$. It is conjectured that the W Virginis stars are a rapidly evolving form of the completely mixed post He-flash stars. (auth) (UK)

29100 TEST STAR IN A STELLAR SYSTEM. Marochnik, L. S. (Astrophysical Inst., Dushanbe, USSR). Sov. Astron. AJ (Engl. Transl.), 11: 873-80(Mar.-Apr. 1968).

Translated from Astron. Zh., 44: 1087-96(Sept.-Oct. 1967).

The dynamics of a test star in a system of field stars is considered, taking into account the collective properties of the latter. (auth)

29101 GENERALITIES ON RADIATION TRANSFER AND CONTINUOUS RADIATION OF ACCELERATED CHARGED PARTICLES. Lequeux, J. (Observatoire de Paris, Meudon, France). pp 1-16 of High Energy Astrophysics. Vol. I. DeWitt, C.; Schatzman, E.; Veron, P. (eds.). New York, Gordon and Breach, Science Publishers, Inc., 1967. (In French).

Photometric definitions used in radio astronomy are reviewed. The energy transfer equation is given. The continuous emission and absorption coefficients and the general expressions for j_ν and κ_ν are derived. The equations describing the classical electromagnetic radiation of a charge accelerated in vacuum are given. (tr-auth)

29102 ELEMENTARY PROCESSES OF IMPORTANCE FOR COSMIC-RAY ASTROPHYSICS AND GAMMA AND X-RAYS ASTRONOMY. Ginzburg, V. L. (Lebedev Inst. of Physics, Moscow). pp 17-103 of High Energy Astrophysics. Vol. I. DeWitt, C.; Schatzman, E.; Veron, P. (eds.). New York, Gordon and Breach, Science Publishers, Inc., 1967.

Topics discussed include: processes taking place under cosmic conditions with electrons, positrons, protons, nuclei, and photons; synchrotron radiation; scattering of relativistic electrons by photons; bremsstrahlung; ionization losses (some collective processes

occurring in a plasma); comparison of the different energy losses of fast charged particles; generation of electrons and positrons; and generation and absorption of γ and x rays. (W.D.M.)

29103 SOME ASTROPHYSICAL APPLICATIONS OF SYNCHROTRON RADIATION: THEORY OF SPECTRA OF RADIO SOURCES. Lequeux, J. pp 105-31 of High Energy Astrophysics. Vol. I. DeWitt, C.; Schatzman, E.; Veron, P. (eds.). New York, Gordon and Breach, Science Publishers, Inc., 1967. (In French).

The elementary processes of radiation and of the energy losses by relativistic charged particles are considered. A real radio spectrum can be different from a power law spectrum for two reasons: absorption phenomena can decrease the low-frequency flux, and the relativistic electron spectrum can be modified by the energy losses they undergo. The way in which these phenomena take account of the properties of the spectra observed and of the flux variation with time is examined. The results obtained are compared with most of the observed radio sources. (J.S.R.)

29104 OPTICAL OBSERVATIONS OF RADIO GALAXIES AND QUASI-STELLAR OBJECTS. Rubin, V. C. (Carnegie Institution of Washington, D. C.). pp 133-51 of High Energy Astrophysics. Vol. I. DeWitt, C.; Schatzman, E.; Veron, P. (eds.). New York, Gordon and Breach, Science Publishers, Inc., 1967.

In this lecture, optical observations of radio galaxies and quasars are reviewed. Most of these observations are reported in the current literature. It is seen that even with the observational material which is presently available, problems still remain concerning the nature of these objects. (W.D.M.)

29105 OPTICAL IDENTIFICATIONS OF RADIO GALAXIES. Veron, P. (Observatoire de Paris, Meudon, France). pp 153-61 of High Energy Astrophysics. Vol. I. DeWitt, C.; Schatzman, E.; Veron, P. (eds.). New York, Gordon and Breach, Science Publishers, Inc., 1967.

The first optical identifications of radio sources are briefly reviewed. Identifications in statistical samples of radio sources are discussed in terms of normal radio galaxies, different types of radio galaxies, double and multiple galaxies, clusters of galaxies, and collisions of galaxies. (W.D.M.)

29106 RADIOELECTRIC PROPERTIES OF GALAXIES. Lequeux, J. pp 163-79 of High Energy Astrophysics. Vol. I. DeWitt, C.; Schatzman, E.; Veron, P. (eds.). New York, Gordon and Breach, Science Publishers, Inc., 1967. (In French).

The distribution of radio luminosity shows a very clear separation between two classes of objects: those for which $P > 8 \times 10^{22}$ W Hz^{-1} sr^{-1} are called radio galaxies and those for which $P < 8 \times 10^{22}$ W Hz^{-1} sr^{-1} are called normal galaxies. These two classes are studied separately. The identification, diameter and structure, and radio spectrum of normal galaxies are summarized. The statistical properties of radio galaxies are outlined. The characteristics of some particular cases are discussed. The function of luminosity and distribution of luminosity are considered with respect to the lifetime of the radio galaxies. The possible utilization of the data on radio galaxies to resolve cosmological problems is discussed. (tr-auth)

29107 RADIO OBSERVATIONS OF QUASI-STELLAR RADIO SOURCES. Veron, P. pp 183-94 of High Energy Astrophysics. Vol. I. DeWitt, C.; Schatzman, E.; Veron, P. (eds.). New York, Gordon and Breach, Science Publishers, Inc., 1967. (In French).

An attempt is made to determine the essential radio characteristics of quasars. The structure and spectra are derived and variations from these are discussed. The distribution of luminosity is discussed. (J.S.R.)

29108 EVOLUTION OF DENSE STAR SYSTEMS. Gold, T. (Cornell Univ., Ithaca, N. Y.). pp 195-9 of High Energy Astrophysics. Vol. I. DeWitt, C.; Schatzman, E.; Veron, P. (eds.). New York, Gordon and Breach, Science Publishers, Inc., 1967.

The evaluation of dense star systems is discussed briefly, and a possible mechanism for quasars is mentioned. (W.D.M.)

29109 DISCUSSION OF OBSERVATIONS OF QUASI-STELLAR RADIO SOURCES, RADIO GALAXIES, AND SUPERNOVAE REMNANTS. Woltjer, L. pp 203-21 of High Energy Astrophysics. Vol. I. DeWitt, C.; Schatzman, E.; Veron, P. (eds.). New York, Gordon and Breach, Science Publishers, Inc., 1967.

The discovery of radio galaxies and quasars poses two extremely interesting problems. The first problem deals with the energetics, i.e., with the origin of the large amount of energy which is stored in these objects. The release of this energy as synchrotron radiation requires the presence of magnetic fields and accelerating processes whose nature is the second problem. Topics covered by this lecture include interpretation of the red shifts of the quasars; inverse Compton radiation in quasars, energetics of radio galaxies and quasars, magnetic fields of radio galaxies, and supernova remnants. (W.D.M.)

29110 OBSERVATIONAL COSMOLOGY. Schucking, E. L. (Univ. of Texas, Austin). pp 223-44 of High Energy Astrophysics. Vol. I. DeWitt, C.; Schatzman, E.; Veron, P. (eds.). New York, Gordon and Breach, Science Publishers, Inc., 1967.

Topics covered in this lecture include some theoretical aspects of the red shift, observation of red shifts, anisotropic fluxes (aberration), definition of distance, Scott effect, evolution of galaxies, observational cosmology, data of cosmological importance, density of matter in the Universe, age of the Universe, the Friedman models, and groups of motion. (W.D.M.)

29111 A LUMINOUS COMPACT GALAXY WITH STRONG Fe II EMISSION LINES. Sargent, Wallace L. W. (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. J., 152: L31-4 (Apr. 1968).

The Zwicky compact galaxy I Zw 0051 + 12 has a stellar nucleus which radiates an unusual spectrum composed of broad emission lines of hydrogen and Fe II superposed on a blue continuum. No absorption lines are seen. The object has a red shift of 18150 km sec^{-1}, $m_v = 13.95$ and $M_v = -23.2$ (with $H = 75$ km sec^{-1} Mpc^{-1}). The colors and spectrum of I Zw 0051 + 12 are very similar to those of 3C 273. The absolute magnitude of the object lies near the lower boundary of the range occupied by QSOs if the latter's red shifts are cosmological. I Zw 0051 + 12 is not a radio source. Information on the structure of I Zw 0051 + 12 is presented and some limits on the physical conditions in its nucleus are derived. (auth)

29112 A MECHANISM FOR CONTINUUM RADIATION FROM QUASI STELLAR RADIO SOURCES WITH APPLICATION TO 3C 27B. Sturrock, P. A.; Feldman, P. A. (Inst. for Plasma Research, Stanford, Calif.). Astrophys. J., 152: L39-44 (Apr. 1968).

This mechanism requires a quasar model in which the central object is magnetically coupled to intergalactic space. Intergalactic plasma is accreted and flows inward, attaining supersonic speeds. The kinetic energy of this gas is converted to (relativistic) electron thermal energy at a collision-free shock front. The electron energy is rapidly radiated by the synchrotron process. The source 3C 273B is discussed quantitatively, and it is shown that the physical characteristics of the line-emission region and of the meter-wave radio region are consistent with those proposed for the continuum-emission region. (auth)

29113 APPLICATION OF NONEQUILIBRIUM STATISTICAL MECHANICS TO STELLAR DYNAMICS. Muriel, A. (State Univ. of New York, Stony Brook). Nuovo Cim., B, 55: 276-9 (May 11, 1968).

Recently, some important conclusions have been reached by the modification and application of some techniques used in nonequilibrium statistical mechanics, one of which is the nonergodicity of homogeneous, infinite gravitational systems. The formalism used has in it the explicit influence of the initial conditions, although it has not been fully discussed as yet. The purpose of this letter is to introduce a set of equations that could be used to describe inhomogeneous systems. (W.D.M.)

29114 CONFORMALLY HOMOGENEOUS MODEL UNIVERSES. I. Edelen, D. G. B. (Purdue Univ., Lafayette, Ind.). Nuovo Cim., B, 55: 155-70 (May 11, 1968).

Einstein equations with a cosmological term are considered in the case of a homogeneous and isotropic universe. The consequences which may occur if the neutrino fluid is effectively dominant are analyzed. (J.F.P.)

29115 INFRARED OBSERVATIONS OF THE CRAB NEBULA. Becklin, E. E. (California Inst. of Tech., Pasadena); Kleinmann, D. E. Astrophys. J., 152: L25-30 (Apr. 1968).

Recent observations of the Crab Nebula in the 1.5- to 5-μ range were made independently at the facilities of the California Inst. of Technology and the University of Arizona. The new observations are summarized and discussed. (W.D.M.)

29116 INTENSITY OF GAMMA-RAYS AT THE LUNAR SURFACE DUE TO ^{26}Al, ^{22}Na, AND ^{54}Mn. Biswas, M. M. (Technical Teachers' Training Inst., Calcutta). Nuovo Cim., B, 55: 256-7 (May 11, 1968).

The intensity at the lunar surface of γ quanta of 1.83, 1.28, and 0.84 MeV due to ^{26}Al, ^{22}Na, and ^{54}Mn, respectively, is estimated roughly according to the principle of the additivity of radiation effects. (W.D.M.)

29117 IS THERE TECHNETIUM IN HR 1105. Davis, Dorothy N. (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. J., 152: L13-15 (Apr. 1968).

The four strongest Tc I lines are very close to prominent lines of rare earths. Hence, in stars rich in rare earths, such as HR 1105 (S5,3), such lines may easily be mistaken for Tc I, unless very accurate measurements are made on the highest-dispersion plates. Only slight evidence for Tc I is found. Evolutionary implications of the lack of technetium in HR 1105 are briefly discussed. (auth)

29118 NOVA-LIKE BEHAVIOR OF THE X-RAY SOURCE CENTAURUS XR-2. Chodil, G.; Mark, Hans; Rodrigues, R.; Swift, C. D. (Univ. of California, Livermore). Astrophys. J., 152: L45-8(Apr. 1968). (UCRL-70778).

The results of six observations of Cen X-2 are compared. These observations were made over a period of two years and indicate that Cen X-2 emits x rays with a time dependence very much like that of a nova emitting in the visible spectrum. Proportional counters were used on all six flights to detect the x rays. (W.D.M.)

29119 OBSERVATIONS OF THE CRAB NEBULA AT λ = 5800 A, 2.2 μ, AND 3.5 μ WITH A 4-MINUTE BEAM. Ney, Edward P. (Univ. of Minnesota, Minneapolis); Stein, Wayne A. Astrophys. J., 152: L21-4(Apr. 1968).

A new photometer was used to observe the Crab Nebula with results of high statistical accuracy at λ = 2.2 and λ = 3.5 μ. In addition, the Crab Nebula was observed at λ = 5800 Å using an Amperex 152-AVP photomultiplier and filter with the same 10-c/s scanning photometer that was used in the infrared measurements. Observations were made on various cold nights in Dec. 1967 and Jan. and Feb. 1968. The results are shown. (W.D.M.)

29120 OBSERVATION OF CEN XR-2 AND OTHER HIGH-ENERGY X-RAY SOURCES IN THE SOUTHERN SKY. Lewin, W. H. G.; Clark, G. W.; Smith, W. B. (Massachusetts Inst. of Tech., Cambridge). Astrophys. J., 152: L49-53(Apr. 1968). (MIT-2098-424).

In the course of a high-energy x-ray sky survey carried out for 8 hrs in a balloon flight from Mildura, Australia, on Oct. 1, 1967, an intense source in Centaurus, a source in Norma, a complex of sources in the galactic plane between l^{II} = 330° and l^{II} = 10°, and an x-ray flare from Sco X-1 were observed. No evidence was found of hard x rays from Lup X-1. The results on Cen X-2, Nor X-2, and Lup X-1 are reported. (W.D.M.)

29121 OBSERVATION OF AN X-RAY FLARE FROM SCO X-1. Lewin, W. H. G.; Clark, G. W.; Smith, W. B. (Massachusetts Inst. of Tech., Cambridge). Astrophys. J., 152: L55-61(Apr. 1968). (MIT-2098-423).

A sudden increase in the x-ray intensity of Sco X-1 was observed in the course of an x-ray survey of the southern sky carried out in a balloon flight on Oct. 15, 1967. The flare-up began near 7:00 hours U.T. and caused a fourfold increase in the counting rate of the lowest channel of the pulse-height analyzer (20 to 30 keV). The intensity rose to a maximum in less than 10 min and then decreased during the next 20 min. If an accompanying optical flare was similar to those which have been observed recently, then its intensity was less than 1% of the value predicted for a thermal-bremsstrahlung spectrum. (W.D.M.)

29122 POSSIBLE CONNECTIONS BETWEEN QUASI-STELLAR OBJECTS AND GALAXIES. Dautcourt, G. (Deutsche Akademie der Wissenchaften zu Berlin). Nuovo Cim., B, 55: 292-5(May 11, 1968).

It is stated that the quasar state could mark the beginning of the life of a galaxy as a radio galaxy. Subsequent explosions and ejections of plasma clouds might have had a similar, on the average less violent, character, but they should have appeared as those of an ordinary radio galaxy, without large increases of optical brightness. Following a statistical method developed by Schmidt, the question of whether this particular evolutionary picture is compatible with the observed space densities and estimated lifetimes of quasars, radio galaxies, and galaxies is discussed. (W.D.M.)

29123 RADIO SPECTRUM OF NGC 4278. Lang, Kenneth R. (Stanford Radio Astronomy Inst., Calif.); Terzian, Yervant. Astrophys. J., 152: L63-4(Apr. 1968).

The flux densities of the elliptical galaxy NGC 4278 were measured at Arecibo at 611, 430, and 195 MHz with beam widths of 9'.2, 10'.0, and 34'.0, respectively. Right-ascension drifts and declination scans of 8-min duration at an angular rate of 15° hr^{-1} were integrated at 5-sec intervals and compared to similar observations of 3C 191, 3C 245, and 3C 287. Flux densities of the galaxy were obtained. (W.D.M.)

29124 RATE OF THE PROTON-PROTON REACTION. Bahcall, John N.; May, Robert M. (California Inst. of Tech., Pasadena). Astrophys. J., 152: L17-20(Apr. 1968).

The rate of the proton-proton reaction was recalculated. The value for the low-energy cross-section factor is $S(E = 0) = (3.78 \pm 0.15) \times 10^{-25}$ MeV barns, which is 12.5% larger than the value in current usage. The effect of larger calculated S(E = 0) on the ^8B solar neutrino flux and on the rate of nuclear-energy generation in the proton-proton chain is briefly discussed. (auth)

29125 RADIO SOURCES WITH PEAKED SPECTRA. Kraus, J. D. (Radio Observatory, Columbus, Ohio); Scheer, D. J.; Dixon, R. S.; Fitch, L. T.; Andrew, B. H. Astrophys. J., 152: L35-8(Apr. 1968).

In a sky survey being made with the Ohio State Univ. 260-foot radio telescope, a number of sources have been found which have a peak in their spectrum at a frequency above 0.5 GHz. The survey is being conducted at three frequencies: 612, 1415, and 2650 MHz with 1415 MHz as the principal frequency. Measurements at these frequencies have been supplemented by ones at 3.2, 6.5, and 10.7 GHz with the 150-foot Algonquin Park radio telescope. Data on the sources are presented. (W.D.M.)

29126 STATE OF IONIZATION OF OXYGEN IN THE SOLAR WIND. Hundhausen, A. J.; Gilbert, H. E.; Bame, S. J. (Los Alamos Scientific Lab., N. Mex.). Astrophys. J., 152: L3-5 (Apr. 1968). (LA-DC-9329).

It is pointed out that the ionization state of a given element is established deep within the corona and is little affected by the expansion of the coronal material to 1 AU. Thus, the ionization state observed at the latter distance is a direct indication of the temperature of the corona. This is in contrast with other quantities measured in the solar wind, such as flow velocity, density, or particle temperatures, which depend strongly on the details of the coronal expansion. (W.D.M.)

29127 THE DISTRIBUTION OF POLARIZATION IN THE CRAB NEBULA AT A WAVELENGTH OF 9.8 CM. Downs, G. S.; Thompson, A. R. (Radio Astronomy Inst., Stanford, Calif.). Astrophys. J., 152: L65-9(Apr. 1968).

The distribution of linearly polarized radiation over the Crab Nebula was measured at a wavelength of 9.8 cm with a synthesized beam 1'.55 by 3'.3. The polarized source is 2'.3 ± 0'.2 east-west by 1'.5 ± 0'.2 north-south at the half-power level and is centered 0'.2 east and 0'.4 south of the center of the total radiation. The maximum observed polarization near the center of the nebula is 6.1%. A comparison of the radio and optical polarized brightness suggests that, at very short wavelengths, depolarization occurs strongly in the northwestern part of the nebula but that, at longer wavelengths, it is more uniformly distributed. (auth)

29128 WHITE-DWARF AND NEUTRON-STAR INTERPRETATIONS OF PULSATING RADIO SOURCES. Thorne, Kip S. (Univ. of Chicago); Ipser, James R. Astrophys. J., 152: L71-5(Apr. 1968).

The recently discovered pulsating radio sources are very probably not neutron stars, since neutron-star models with the observed pulsation periods (~1.3 sec) are energetically unbound. The white-dwarf interpretation is more promising: White dwarfs typically have fundamental periods between 3 and 50 sec; but there might exist white dwarfs with fundamental periods as low as 1.3 sec. The pulsations of a white dwarf can be excited by unstable nuclear burning in the stellar envelope. Envelope burning would preferentially excite the harmonic modes, which typically have periods near 1 sec, rather than the slower fundamental mode. (auth)

29129 MAGNETIC FIELD IN SOME PROMINENCES MEASURED WITH THE He I, 5876 A LINE. Harvey, J. W.; Tandberg-Hanssen, E. (High Altitude Observatory, Boulder, Colo.). Solar Phys., 3: 316-20(Feb. 1968).

Observations of the longitudinal magnetic field of several prominences were made with the D_3, Hα, and Hβ lines. There is no significant difference in the magnetic field measured with the helium and hydrogen lines. The possibility of a true difference in the fields on a scale much finer than that of our observations is not excluded. (auth)

29130 ANALYSIS OF TIME VARIATIONS IN THE INTERPLANETARY RADIATION INTENSITY OBSERVED BY MARINER 4. McCoy, James E.; Anderson, Hugh R. (Rice Univ., Houston, Tex.). J. Geophys. Res., 73: 2911-17(May 1, 1968). (NP-17319).

An experiment consisting of a shielded Geiger tube and an ionization chamber, sensitive to electrons ≥1 MeV and protons >10 MeV, was flown on Mariner 4. The data returned by this experiment are analyzed for time variations with periods from two minutes to several days by means of Tukey's digital power spectral

density techniques. The power spectra obtained show very little periodic variation present, other than occasional small-amplitude peaks that seem to be randomly distributed with respect to period and which may be associated with solar particle disturbances. These features are interpreted as indicative of local structure or hydromagnetic waves in the interplanetary magnetic field. The observed radiation modulations, typically 1% of the average intensity, could result from modulation by magnetic structure of characteristic dimensions 10^5 to 10^7 km. Some of the shorter-period variations observed are difficult to attribute to magnetic field structure. (auth)

29131 SPACE–TIME STUDY OF SOLAR GRANULATION. IMPROVEMENT OF DEFORMED IMAGES BY ATMOSPHERIC TURBULENCE. Mein, Pierre (Observatoire de Paris, Meudon, France). Ann. Astrophys., 31: 115-22(Jan.-Feb. 1968). (In French).

A sequence of plates of solar granulation was analyzed in the frequency–wave number plane using a new numerical method to reduce the effects of image distortion by atmospheric turbulence. Results previously obtained by Lévy [1967] from plates by Rösch and Hugon were thus improved and data on image distortion obtained. The spectrum of the granulation is mainly concentrated in the low-frequency region (T > 600 s); intermediate frequency oscillation (T = 300 s) were probably detected but acoustic waves could not be detected in the investigated range of frequencies (T > 120 s). (auth)

29132 ENHANCEMENT OF THE STIMULATED EMISSION OF RADIO-FREQUENCY LINES OF HYDROGEN. McCarroll, R. (Observatoire de Paris, Meudon, France); Hoang Binh Dy. Ann. Astrophys., 31: 123-7(Jan.-Feb. 1968).

Goldberg has shown how very small departures of the level populations from thermal equilibrium can enhance the stimulated emission of radio-frequency lines emanating from H II regions. Taking into account the various processes which populate and depopulate the highly excited states under typical nebular conditions, the differential departures from the equilibrium population for electron densities ranging from 10 to 10^4 cm^{-3} were calculated. The most remarkable feature of the results is their sensitivity to the electron density. (auth)

29133 MARS MARINER 4 RADIO OCCULTATION EXPERIMENT: COMMENTS ON THE UNIQUENESS OF THE RESULTS. Harrington, J. V. (Massachusetts Inst. of Tech., Cambridge); Grossi, M. D.; Langworthy, B. M. J. Geophys. Res., 73: 3039-41(May 1, 1968).

A number of model atmospheres that are characterized by increasing scale heights were studied. The corresponding ionospheric component was then determined that gives agreement with the measured total refractivity. It was found that the atmospheres having a range of scale heights from 9 to 15 km can be made consistent with the measurements if a low-altitude ionospheric layer of 3×10^4 to 9×10^4 electrons/cm^3 is assumed in the Martian atmosphere. (W.D.M.)

29134 SOLAR SPICULES. Beckers, J. M. (Sacramento Peak Observatory, Calif. Cambridge Research Labs., Sunspot, N. Mex.). Solar Phys., 3: 367-433(Mar. 1968).

Observational techniques are described briefly and observations of spicules outside the limb are reviewed. The line intensities of spicules outside the limb are interpreted. The magnetohydrodynamic models of spicules and their behavior when seen against the emission of the solar disk are discussed. (W.D.M.)

29135 OBSERVATION OF SCATTERED L_α RADIATION IN THE VICINITY OF THE EARTH AND IN INTERPLANETARY SPACE. Kurt, V. G. Kosm. Issled., 5: 911-20(Nov.-Dec. 1967). (In Russian).

Measurements were made of the scattered ultraviolet radiation in two ranges λ1050 to 1340 and 1225 to 1340 Å by the interplanetary stations Venera-2 and Venera-3, launched on September 12 and 16, 1965. From the intensity of the radiation in the first range, with inclusion of the line L_α (λ 1216 Å), the density of atomic hydrogen near the Earth was calculated at 20 R_E (Venera-2) and 7 R_E (Venera-3). At a distance of $5R_E$ the density was equal to 25 cm^{-3}. At greater distances from the Earth, the concentration of neutral hydrogen decreased proportionally to $R^{-2.1}$ and $R^{-2.3}$. The measured density is in good agreement with data of the previous measurement by Zond-1. In interplanetary space far from the Earth the intensity of the L_α emission is equal to 7×10^{-5} erg/cm^2·sec·sterad, which agrees with the density of the neutral components of interplanetary space of $\sim 3 \times 10^{-3}$ cm^{-3} for the "hot" interplanetary gas model. With a precision of ~30% the intensity remained constant during the measurement period from November 1965 to January 1966. A slow systematic increase of the intensity, approximately 20 to 30% as the spacecraft approaches the Sun, was observed. At the time of the chromospheric flare Mark-2, an increase in the intensity of the scattered L_α radiation was not observed. Correlation with the area of calcium flocculi and spots on the solar disc was not detected. A counter, sensitive in the range from λ1225 to 1340 Å, recorded a background, connected with cosmic radiation, during which the intensity of the ultraviolet radiation did not exceed 10^{-7} erg/cm^2 sec·sterad. (tr-auth)

29136 STRUCTURE OF THE RADIO GALAXIE FORNAX A. Kazes, I. (Observatoire de Paris, Meudon, France); Le Squeren, A.-M. Ann. Astrophys., 31: 153-5(Jan.-Feb. 1968). (In French).

Both components of the radio source Fornax A are shown to be assymetric. No fine structure larger than one minute of arc was detected. (auth)

29137 VERY-HIGH-RESOLUTION STUDY OF THE $B\,^2\Sigma^+ \rightarrow A\,^2\Sigma^+$ TRANSITION OF OH AND OD WITH AID OF A HIGH-FREQUENCY SOURCE UTILIZING THE JET EFFECT. Czarny, J. (Observatoire de Paris, Meudon, France); Felenbok, P. Ann. Astrophys., 31: 141-52(Jan.-Feb. 1968). (In French).

Using a water vapor jet excited by a high-frequency source, the spectrum of the $B\,^2\Sigma^+ - A\,^2\Sigma^+$ system of OH and OD was studied at high resolution. The doublet structure from the head on was resolved and the intensity of each component is given. The satellite line $^PQ_{1,2}(1)$ and the following perturbations were observed: change of γ sign between $v'' = 5$ and $v'' = 6$; rotational lines half-width variation for the 0.8, 0.7, 0.6 bands; and increase of the half-width for $K \geq 6$ in the 0.8 band of OH. (auth)

29138 POSSIBILITIES FOR AMPLIFICATION OF GYROMAGNETIC SYNCHROTRON RADIATION FROM A VERY RELATIVISTIC NONCOLLECTIVE PLASMA. Heyvaerts, M. J. (Institut d'Astrophysique, Paris). Ann. Astrophys., 31: 129-39(Jan.-Feb. 1968). (In French).

An analysis was made of the possibilities of amplification of synchrotron radiation, taking into account the detailed form of the radiation diagram; collective effects were neglected. In one polarization, the amplification is never possible, in the other it can occur in the presence of particle beams with angular spread of the order of the aperture angle of the radiation diagram. (auth)

29139 SOME OBSERVATIONS BEARING ON THE PROBLEM OF THE SHORT-PERIOD OSCILLATIONS. Howard, Robert (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena); Livingston, William C. Solar Phys., 3: 434-8 (Mar. 1968).

Observations of solar velocity fields made simultaneously at Mount Wilson and at Kitt Peak with the same size aperture (5 arc-sec) and same position on the disk (±1 arc-sec) are presented. The object is to clarify whether the short-period oscillations (SPO's) previously reported (Howard, 1967), could be caused by local seeing conditions. The time of onset and general character of the SPO's are found to be well correlated for the two sites, a condition that favors a solar origin. However, because correlation in complete detail did not prove possible, some doubt must remain regarding the source of the SPO's. (auth)

29140 INFLUENCE OF SEEING ON PHOTOSPHERIC VELOCITY MEASUREMENTS. Deubner, Franz Ludwig (Fraunhofer Institut, Freiburg i. B.). Solar Phys., 3: 439-47(Mar. 1968).

It is shown that the short-period fluctuations of photospheric velocity records can be explained by the scanning effect of atmospheric seeing (image motion) and the velocity gradients present on the solar surface. Some observations supporting this explanation are presented. (auth)

29141 FURTHER COMMENTS ON THE SPO PROBLEM. Livingston, W. C. (Kitt Peak National Observatory, Tucson, Ariz.). Solar Phys., 3: 448-9(Mar. 1968).

Experiments performed at Kitt peak to verify the solar origin of SPO (short-period oscillation) events are briefly summarized. (W.D.M.)

29142 COMPTON EFFECT INTERPRETATION OF SOLAR REDSHIFT. Kierein, J. W.; Sharp, B. M. (McDonnell Douglas Corp., St. Louis). Solar Phys., 3: 450-3(Mar. 1968).

The hypothesis that the solar redshift is due to Compton scattering of solar radiation through the electrons in the solar atmosphere predicts a variation in magnitude of the redshift with position in good agreement with observation. Quasar redshifts may be similarly explained. (auth)

29143 STRUCTURE OF A SUNSPOT. II. THE MAGNETOHYDRODYNAMICS OF THE PENUMBRA. Wilson, P. R. (Joint Inst. for Laboratory Astrophysics, Boulder, Colo.). Solar Phys., 3: 454-65(Mar. 1968).

It is shown that horizontal radial flow in the penumbra is not

inconsistent with a vertical component of the penumbral magnetic field. The magnetic amplification produced by the stretching of the magnetic-flux tubes in this velocity field yields a resultant field whose typical inclination to the horizontal is about 20°. It is shown that the thermal convection forces can balance the magnetic forces restraining this flow and that the magnetic energy produced by the stretching of the flux tubes is of the same order of magnitude as the sunspot-energy deficit. Finally, a mechanism is suggested for dispersing this magnetic energy over a large region of the solar surface. (auth)

29144 CONCERNING THE ORIGIN OF EVERSHED MOTION IN SUNSPOTS. Altschuler, Martin D.; Nakagawa, Yoshinari; Lilliequist, Carl G. (National Center for Atmospheric Research, Boulder, Colo.). Solar Phys., 3: 466-81(Mar. 1968).

The nonlinear, partial differential equations of magnetohydrodynamics were iterated simultaneously by computer to determine the time development of a single sunspot. Axisymmetry and incompressibility were assumed. The initial conditions were (1) zero velocity everywhere, and (2) the magnetic-field distribution of a ring current embedded in the photosphere. The initial magnetic field was then allowed to relax by magnetic diffusion and by the creation of a velocity field. It is shown that (1) Evershed motion outward from the sunspot will develop from a wide range of reasonable initial parameters, and (2) the growth rate of the magnetic configuration depends on the strength of the initial magnetic field. (auth)

29145 RADIAL PULSATIONS OF ROTATING STARS. II. Occhionero, F. (Laboratorio di Astrofisica, Rome). Ann. Astrophys., 31: 1-4(Jan.-Feb. 1968).

In connection with Paper I, a second "static" rotational correction to the eigenfrequencies of radial motion is evaluated. No distinction arises between the even and the odd modes of pulsation and the effect is almost always of the destabilizing type. All the basic conclusions of Paper I are reinforced. (auth)

29146 MAGNETOGASDYNAMIC MODEL OF STELLAR CORONA. Tarafdar, S. P. (Tata Inst. of Fundamental Research, Bombay). Ann. Astrophys., 31: 5-14(Jan.-Feb. 1968).

A magnetogasdynamic model of the stellar corona was developed, assuming that the magnetic energy density is greater than the thermal energy density as well as the kinetic energy density. The magnetic field configuration was obtained and the possibility of a static and steady-state corona is discussed. It is shown that the corona cannot be static in the isothermal or polytropic case nor in the case when temperature falls slower than $1/r$. The steady-state corona, with temperature given by either isothermal or polytropic law, gives a velocity which increases with distance from the base. The model gives a particle density which falls faster along the pole than along the equator. The variation of the particle flux in the corona is found to be independent of the temperature law. Finally, the model is compared with observed results from the interplanetary medium. (auth)

29147 ANALYSIS OF METALLIC-LINE STARS. II. CHEMICAL COMPOSITION AT ζ LYR A. NEAR INFRARED SPECTRA OF FIVE A_m. Praderie, Francoise (Observatoire de Paris, Meudon, France). Ann. Astrophys., 31: 15-41(Jan.-Feb. 1968). (In French).

A detailed analysis is presented of the blue and visible spectra of ζ Lyr A. The chemical composition of this star was determined by the method atmospheres. Carbon and scandium are deficient in this star, whereas strontium, zirconium, barium, and europium are clearly overabundant. The possibility of observing the resonance doublet of lithium is discussed. In addition, the near infrared spectra of five A_m stars were studied. The abundances of oxygen and nitrogen were obtained, as well as the intensities of the spectral lines in the Paschen series of hydrogen (P_{12} to P_{16}). (auth)

29148 ABUNDANCE DETERMINATIONS FOR TWO F-TYPE MAIN-SEQUENCE STARS, HR 4533 AND HR 4657. Cayrel de Strobel, G. (Goddard Space Flight Center, New York). Ann. Astrophys., 31: 43-61(Jan.-Feb. 1968).

A detailed analysis of the atmospheres of the stars HR 4533 = HD 102634 and HR 4657 = HD 106516 relative to the Sun was performed using high-dispersion spectra and model atmosphere technics. The detailed analysis of HR 4533 leads to an effective temperature $T_{eff} = 6050°K$, a surface gravity $\log g = 4.3$, a microturbulent velocity $v_{mt} = 2.0$ km/s, and an abundance ratio [Fe/H] = +0.14. The detailed analysis of HR 4657 leads to an effective temperature $T_{eff} = 6050°K$, a surface gravity $\log g = 4.3$, a microturbulent velocity $v_{mt} = 1.4$ km/s, and an abundance ratio [Fe/H] = −0.40. (auth)

29149 INTERFEROMETRIC STUDY OF IONIZED HYDROGEN IN M 33: NEW KINEMATICAL AND PHYSICAL DATA. Carranza, G. (Observatoire, Cordoba, Argentina); Courtes, G.; Georgelin, Y.; Monnet, G.; Pourcelot, A. Ann. Astrophys., 31: 63-100(Jan.-Feb. 1968).

The radial velocities of 1048 points over M 33 were obtained by an interference method, using the H_α and [N II] lines, with a mean dispersion of 22 Å/mm. A general field of hydrogen not linked to the arms of M 33 (called "disk component") was traced up to 15′ from the nucleus. The large number of points observed yield the following results: (1) The rotation curve of the disk was obtained, the expansion motions found are insignificant (<3 km/s). (2) A velocity discontinuity of 15 km/s was found between the general field and the arms, with the arms rotating faster than the disk. The velocity dispersion, small for the arms ($\sigma \sim 9$ km/s), even smaller in the disk ($\sigma \sim 5$ km/s), proves that the ionized hydrogen belongs to an extreme population I. The rotation curves, obtained for the arms up to 25′ from the center, show a 40 km/s dissymmetry between the northern and southern arms. (3) The mass density as a function of distance from the center was obtained up to 7′5 from the nucleus. (4) The ratio $H_\alpha/[N\ II]$, which was obtained in the disk up to 15′ from the nucleus, is lower than it is in the arms. This suggests a high electron temperature ($T_e \approx 11{,}000°K$) in the disk. (auth)

29150 SOME REMARKS ON THE FORMATION OF Ca II AND Mg II LINES IN THE LOWER CHROMOSPHERE. Dumont, Simone (Observatoire de Paris, Meudon, France). Ann. Astrophys., 31: 101-3(Jan.-Feb. 1968). (In French).

New theoretical estimates of intensities are presented for the emission peaks found at the centers of the Mg II and Ca II resonance lines. The two-level-atom approximation is shown to be acceptable for Mg II but not for Ca II. (auth)

29151 MODEL FOR THERMAL GYROMAGNETIC RADIO EMISSION FROM SOLAR-ACTIVE REGIONS. Lantos, Pierre (Observatoire de Paris, Meudon, France). Ann. Astrophys., 31: 105-13(Jan.-Feb. 1968).

The slowly varying, centimeter wavelength radio radiation emitted from the regions above certain centers of solar activity may arise in part from the gyromagnetic process. The present calculations show that, should this hypothesis be true, the structure of the radio regions would exhibit great complexity, and would also appear to change with the solar longitude of the active center. The direct or indirect experimental detection of these properties would furnish an important test of the relevance of the gyromagnetic emission mechanism. (auth)

29152 OBSERVATIONS OF LUNAR SHADOWING OF ENERGETIC PARTICLES. Lin, R. P. (Univ. of California, Berkeley). J. Geophys. Res., 73: 3066-71(May 1, 1968).

Preliminary results are reported from the Univ. of California energetic particle experiment aboard the lunar-orbiting satellite AIMP 2 (Explorer 35). By comparing AIMP 2 observations with simultaneous observations by an identical experiment aboard IMP 4 (Explorer 34), the effect of the close presence of the Moon on energetic particle fluxes is unambiguously determined. (W.D.M.)

29153 CHRONOLOGY OF CHONDRITES IN TERMS OF RARE-GAS ISOTOPES. Zaehringer, J. (Max-Planck-Institut fuer Kernphysik, Heidelberg). Meteoritika, No. 27, 25-40(1967). (In Russian).

Discussion of the experimental procedure and results of an investigation of the content of the He, Ne, and Ar isotopes in meteorites is given. The rare-gas contents of chondrites (41 hypersthenic, 33 bronzitic, 10 amphoteric, 1 enstatitic, and 1 pigeonitic) are tabulated. (IAA)

29154 Hα FILAMENT OBSERVED AGAINST THE CHROMOSPHERE AT THE LIMB. Oehman, Yngve (Stockholm Observatory). Solar Phys., 3: 354-6(Feb. 1968).

Observations are reported of an Hα filament clearly visible in the image of the chromosphere at the limb as well as in the Hα spectrum of the same part of the chromosphere. Observations of this kind may give valuable information about the absorption mechanism at work in filaments. (auth)

29155 COLOR IN SOLAR GRANULATION. Evans, John W. (Sacramento Peak Observatory, Calif. Cambridge Research Labs., Sunspot, N. Mex.). Solar Phys., 3: 344-5(Feb. 1968).

Pairs of spectra exposed simultaneously in the yellow and ultraviolet show exactly the same solar granulation in the two colors. This is contrary to Vassilyeva's earlier results. The difference is probably due to her neglect of atmospheric dispersion. (auth)

29156 CORONAL POLAR PLUMES. Newkirk, Gordon Jr.; Harvey, John (High Altitude Observatory, Boulder, Colo.). Solar Phys., 3: 321-43(Feb. 1968).

The purpose of this investigation was to determine what connection exists between coronal plumes and polar surface features. To

this end the properties of plumes were re-examined by making a detailed statistical analysis of photographs of three eclipses (1962, 1963, and 1965) of the last sunspot minimum. It was found that a "typical" plume has a core density $\approx 10^8$ cm^{-3}, a half width $\approx 3.3 \times 10^4$ km, and a density profile with distance r from its axis characterized by $N \approx 10^8\{1 - [r/(3.9 \times 10^4)]\}^{1.6}$. There is some (although only weak) regularity in the projected spacing of plumes with a mean separation of $\approx 7 \times 10^4$ km. The relation between plumes and various surface features is examined. Although little direct evidence can be assembled, it is concluded that a direct connection exists between plumes and photospheric faculae, bright K_3 faculae, and small-scale magnetic structure present in the chromospheric network. It is hypothesized that plumes originate at the bright cores of the rosettes which lie along the chromospheric network. The distribution of magnetic field in the corona above a surface covered with idealized chromospheric network cells is calculated. The fact that the shape and size of the magnetic flux tubes originating from the rosette agrees with that of observed plumes supports the hypothesis. (auth)

29157 IMPORTANCE OF TEMPERATURE VARIATIONS IN THE FORMATION OF LINE PROFILES. Nussbaumer, H. (University Coll., London). Solar Phys., 3: 349-50(Feb. 1968).

Line profiles, especially of chromospheric and coronal lines, might be influenced appreciably by the joint effects of a temperature gradient and a radial expansion. Temperatures deduced from such profiles could lead to erroneous conclusions concerning the ion temperature of the line-forming matter. (auth)

29158 HIGH-RESOLUTION MEASUREMENTS OF PHOTOSPHERE AND SUNSPOT VELOCITY AND MAGNETIC FIELDS USING A NARROW-BAND BIREFRINGENT FILTER. Beckers, J. M. (Sacramento Peak Observatory, Calif. Cambridge Research Labs., Sunspot, N. Mex.). Solar Phys., 3: 258-68 (Feb. 1968).

Modifications to a Zeiss ¼ Å filter are described which allow high spatial resolution observations of the line-of-sight velocities and magnetic fields in the photosphere and in sunspots. First results show: (1) the granular velocity field to be very strong: differences in upward motions in the granules and downward motions in between are as much as 6 km/sec; (2) the Evershed effect in sunspots to originate primarily in the dark regions between bright penumbral filaments. (auth)

29159 MAGNETIC FIELDS AND FLARES IN THE REGION CMP, 20 SEPTEMBER 1963. Moreton, G. E. (CSIRO, Australia); Severny, A. B. Solar Phys., 3: 282-97(Feb. 1968).

The position of bright knots of 30 flares at their very beginning relative to the high-resolution isogauss maps of the longitudinal component ($H_{||}$) and maps of the transverse component ($H_\perp$) of magnetic field are considered for seven days during the passage of the active and large spot group in Sept. 1963. The flare bright knots occur simultaneously in regions of opposite magnetic polarity, and the majority of these knots are adjacent to neutral line $H_{||} = 0$, although not coinciding precisely with this line. Lenticular form of flare knots and the motions of bright material of flares is restrained by transversal field $H_\perp$. Also flares are closely associated (83%) with so-called "bifurcated regions," where specific crossing of transverse components takes place. There is well-expressed (80%) coincidence of flare knots with the strongest (positive or negative) electric currents as determined from the relation $j = c/4\pi$ rot H. The relation of results obtained to some existing theories of flares is briefly discussed. (auth)

29160 PARAMETERS OF THE PLASMA AFFECTING THE RADIATION OF PULSAR 1. Tanenbaum, B. S.; Zeissig, G. A.; Drake, F. D. (Cornell Univ., Arecibo, Puerto Rico). Science, 160: 760(May 17, 1968).

Analysis of the relation between time delay and frequency for pulses from Pulsar 1 shows that the dispersive region of the ray path must exceed 300 au and have an average electron number density less than 8000 per cubic centimeter and average magnetic field strength less than 2×10^{-3} gauss. These requirements almost guarantee that the observed dispersion takes place in the interstellar medium. (auth)

29161 PULSE STRUCTURE OF FOUR PULSARS. Drake, F. D.; Craft, H. D. Jr. (Cornell Univ., Arecibo, Puerto Rico). Science, 160: 758-60(May 17, 1968).

The pulse structure of the four known pulsars is given. The pulse is about 38 milliseconds for the two pulsars of longest period, and within the pulsewidth three subpulses typically appear. The pulsar of next longest period typically radiates two pulses separated about 23 milliseconds in time. The one short-period pulsar emits single pulses of constant shape. The first subpulses of all pulsars have nearly the same shape. The shape of the first subpulse agrees well with the pulse shape expected from a radio-emitting sphere which is excited by a spherically expanding disturbance, and in which the radio emission, once excited, decays exponentially. (auth)

29162 RESOLUTION OF THE Hα DOUBLE-LIMB CONTROVERSY. White, O. R.; Simon, G. W. (Sacramento Peak Observatory, Calif. Cambridge Research Labs., Sunspot, N. Mex.). Solar Phys., 3: 269-81(Feb. 1968).

The discussion of the Hα double limb had reached the point where the question of its existence as a real solar phenomenon could not be resolved without new observations made with the Lockheed filter and the Mount Wilson spectroheliograph. A study of the instrumental profiles had indicated that there was sufficient off-band light to produce the observed inner limb step in the Mount Wilson instrument, but this analysis was not completely satisfactory because of limitations inherent in the measurement of instrument functions with a ^{198}Hg source. The instrumental profile work did indicate, however, that the spectral purity of the instruments in question could be substantially improved by the use of narrow-band interference filters. An experimental program was thus launched to determine the effect of such a blocking filter on the appearance of the Hα limb. The results of these observations with three Halle filter systems and the Mount Wilson spectroheliograph are that the inner limb completely disappears at the center of Hα when a blocking filter is used to reduce unwanted light, which originates at wavelengths beyond ±0.8 Å. In addition, the contrast and visibility of the chromospheric fine structure is increased by eliminating the off-band light. Thus the experiment conclusively demonstrates that the apparent inner limb is not a solar feature but is due entirely to instrumental parasitic light. (auth)

29163 SOME FEATURES OF RELATIVE SUNSPOT NUMBER DURING THE DECLINING PHASE OF SOLAR CYCLE 19. Bhargava, B. N. (Colaba Observatory, Bombay). Solar Phys., 3: 351-3(Feb. 1968).

The lifetimes of most spots are short but some spots are known to persist over periods of one solar rotation or more. It is the larger spots, particularly those which appear during the declining phase of the solar cycle when the spot belts drift to lower solar latitude, that have greater longevity. The probability of a comparatively large number of spots to be long-lived is still greater during periods when the sunspot number and the centimeter wave-flux, an excellent index of long-lived solar activity, are well correlated. The smoothed sunspot number and flux are generally well correlated, but the correlation coefficients computed from the daily values of these parameters during a month vary between wide ranges from month to month. In order to determine a period of several years during which the two indices were best correlated, the coefficients were computed using daily values of the sunspot number and 10.7-cm flux for every month from January 1955 to August 1966, and were found to vary from 0.98 in November 1958 to 0.01 in May 1964. During the period between September 1958 and December 1962, however, the coefficients were 0.70 or better, for 48 of the 52 months. During this period, therefore, sunspots and 10.7-cm radio regions of high longevity appeared on the solar disc. The daily values of relative sunspot number and 10.7-cm flux were utilized, therefore, in the present communication for ascertaining the nature of the periodic behavior of these indices during the 52-month period. (auth)

29164 SPECTRUM OF SLOWLY VARYING COMPONENT OF SOLAR RADIO EMISSION ON MILLIMETER WAVELENGTHS. Tsuchiya, Atsushi (Tokyo Univ.); Takahashi, Kozo. Solar Phys., 3: 346-8(Feb. 1968).

The spectrum of the S-component of solar radio emission was investigated at 4, 17, 35, 70, and 94 GHz. The spectrum for a spot group which appeared late in March 1966 (McMath plage No. 8223), seems to be flat at the frequencies above about 35 GHz. This implies that the emission is due to pure free–free emission at the frequencies above 35 GHz. (auth)

29165 FORMATION OF HEAVY NUCLEI IN NUCLEOSYNTHESIS. Cameron, A. G. W.; Truran, J. W.; Arnett, W. D. (Yeshiva Univ., New York. Goddard Space Flight Center, New York). Ark. Fys., 36: 521-7(1967).

From International Symposium on Why and How Should We Investigate Nuclides Far Off the Stability Line, Lysekil, Sweden. See CONF-660817.

Two of the three processes of nucleosynthesis of heavy nuclei form nuclides off the line of beta stability. These are the process of neutron capture on a fast time scale and the process which produces bypassed nuclei. Both of these processes appear to be associated with supernova explosions. A brief discussion is given of stellar evolution and supernova hydrodynamics, and the above two processes are discussed in this astrophysical context. (auth)

29166 STRUCTURE OF A SUNSPOT. I. THE BIRTH AND DEVELOPMENT OF A SUNSPOT. Wilson, P. R. (Joint Inst. for

Laboratory Astrophysics, Boulder, Colo.). Solar Phys., 3: 243-57(Feb. 1968).

A new model for the structure of a sunspot is put forward. The features of the model are (i) the deep inhibition of convection by magnetic fields, (ii) the formation of a "cool cone" above the region of inhibition of convective transfer by the energy diverted around this region, and (iii) the development of the penumbra by the interaction of strong magnetic field with thermal forces in a region where the opacity prevents the transport of energy by radiation alone. A clear distinction is made between a pore, which results from the inhibition of deep convection across an area considerably greater than that of the pore, and isolated penumbral filaments, which result from strong local fields in the surface regions. It is shown that this new model provides a simple account of the birth and development of a sunspot, and this is contrasted with the difficulties faced by alternative models. (auth)

29167 STABILITY OF FORCE-FREE MAGNETIC FIELDS WITH CYLINDRICAL SYMMETRY IN THE CONTEXT OF SOLAR FLARES. Anzer, Ulrich (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Solar Phys., 3: 298-315 (Feb. 1968).

The problem of the accumulation and storage of the energy released in solar flares is discussed;.it is proposed that convective energy of the photosphere is transformed into magnetic energy of the chromosphere and corona. The consequences of a large ratio of magnetic pressure to gas pressure are investigated. In this case the field must be approximately force-free. The only suitable force-free fields which allow an analytical treatment are those of cylindrical symmetry. The stability of these fields is studied with the energy principle. It is shown that they are always unstable due to kink type instabilities. The shape of the unstable perturbations is described in detail and an upper limit for their amplitude is estimated. The consequences for the proposed mechanism of energy storage are briefly discussed. (auth)

29168 THERMALLY DRIVEN ROSSBY-MODE DYNAMO FOR SOLAR MAGNETIC-FIELD REVERSALS. Gilman, Peter A. (Univ. of Colorado, Boulder). Science, 160: 760-3(May 17, 1968).

There is increasing interest in the possible existence of large eddies or "Rossby waves" in the Sun's convection zone and photosphere. It is shown that many flows of this type, driven by an equator–pole temperature difference, act as hydromagnetic dynamos to produce magnetic fields that periodically reverse. The periods and field amplitudes agree with solar phenomena within an order of magnitude. (auth)

29169 HAUTES ENERGIES EN ASTROPHYSIQUE. VOLUME I. Ecole d'ete de Physique Theorique Cours donnes aux Houches en 1966, avec une subvention de l'OTAN. (High Energy Astrophysics. Volume I. Lectures Delivered at Les Houches During the 1966 Session of the Summer School of Theoretical Physics With a Grant from NATO). DeWitt, C.; Schatzman, E.; Veron, P. (eds.). Universite de Grenoble Ecole d'Ete de Physique Theorique, Les Houches. New York, Gordon and Breach, Science Publishers, Inc., 1967. 259p. $12,50 Cloth, $8.50 Paper. (In English and French).

Separate abstracts were prepared for the ten lectures. (W.D.M.)

For abstracts of individual papers see: 29101–29110.

29170 AGENDA AND DRAFT REPORTS. INTERNATIONAL ASTRONOMICAL UNION THIRTEENTH GENERAL ASSEMBLY, PRAGUE, 22–31 AUGUST 1967. Prague, International Astronomical Union, 1967. 1158p. (In French and English).

The agenda for the 13th General Assembly held in Prague on Aug. 22-31, 1967, is given. Draft reports for thirty-four of the commissions are included. (W.D.M.)

29171 THE EVOLUTION OF STARS. HOW THEY FORM, AGE, AND DIE. Page, Thornton; Page, Lou Williams (eds.). The Macmillan Sky and Telescope Library of Astronomy. Volume 6. New York, The Macmillan Company, 1968. 349p. $7.95.

Eighty articles from Sky and Telescope were organized into eight chapters, to which the editors have added a general introduction, giving a broad description of stellar evolution together with an explanatory introduction to each chapter and an instructive running commentary throughout. A glossary of terms is provided. (W.D.M.)

29172 STELLAR PHYSICS. VOLUME 1. Chiu, Hong-yee. A Blaisdell Book in the Pure and Applied Sciences. Waltham, Mass., Blaisdell Publishing Company, 1968. 574p.

This advanced level text and self-contained source book provides comprehensive account of stellar structure, stellar evolution, and relevant physical processes in stars. Concepts are discussed such as statistical physics, transport processes, the quantum theory of opacity, and weak interactions in astrophysics. Applications of these concepts to stellar physics are given. A detailed discussion of atomic and nuclear physics contains those results required to investigate stellar interiors and stellar evolution. (W.D.M.)

29173 MODELS FOR CARBON–OXYGEN STARS OF ONE SOLAR MASS IN LATE STAGES OF EVOLUTION. Bautz, Laura Patricia. Madison, Wis., Univ. of Wisconsin, 1967. 196p.

Thesis.

Two evolutionary sequences of models for gravitationally contracting, partially degenerate stars of one solar mass were constructed. Sequence I consisted of models for a star having a carbon–oxygen core and a helium envelope which was joined to the core at $\log(M_r/M) = -10^{-4}$. Energy losses due to photo- and plasma neutrino emission were included. Neutrino emission acted as a thermostat which prevented the star from reaching temperatures sufficient to burn carbon. Contraction from $0.13R_\odot$ to $0.01R_\odot$ took place in 1.5×10^6 years. The track on the color magnitude diagram is similar in shape and in average luminosity to the track proposed by Harmon and Seaton (1964) for the evolution of the central stars of planetary nebulae. Radii of the models were consistently smaller than the observations indicate by about a factor of eight, however, and the total range in luminosity was a factor of two less than observed. Since the existence of the photo- and plasma neutrino reactions is still in doubt, a second sequence of carbon–oxygen models without neutrino losses was calculated. The contraction took about one hundred times longer than for the neutrino models. Carbon burning occurred during the contraction and exhausted the carbon in the inner fifty percent of the stellar mass. The shape of the evolutionary track does not resemble the evolution of planetary nebula nuclei. (Disser. Abstr.)

29174 RADIAL VELOCITY SURVEY OF H II REGIONS. Miller, Joseph Standard. Madison, Wis., Univ. of Wisconsin, 1967. 53p.

Thesis.

Radial velocities were measured for 36 galactic HII regions with the 36-inch cassegrain spectrograph of the Kitt Peak National Observatory. Distances based on spectroscopic parallaxes of associated stars were obtained for 31 nebulae from published material, and expected radial velocities were calculated using these distances and a published kinematical model of the Galaxy. If IC 405 is left out because it exhibits significant internal motions, the remaining 30 objects have an rms value for the difference between the velocity expected from the model and that observed of 8.7 km/sec. For the 20 nebulae observed in the Orion and Sagittarius spiral arms, the rms difference is 6.0 km/sec, while the nine located in the Perseus arm have an rms difference of 13.1 km/sec. For five nebulae in the Perseus arm the average value of the observed velocity minus the expected velocity is −15.4 km/sec, and the observations with the 300-foot radio telescope of the National Radio Astronomy Observatory indicate that there are substantial amounts of neutral hydrogen in the directions of these five nebulae with similar velocities. It is found that the motions of HII regions in general are very similar to those of cepheid variables: there does not appear to be any significant differences between the motions of the nebulae and these young stars. It is concluded that the motions of the majority of the HII regions are very well represented by the kinematical model of the Galaxy, and that their velocity dispersion is significantly less than 10 km/sec. (Disser. Abstr.)

Atomic and Molecular Physics

Refer also to abstracts 28070, 28188, 29069, 29258, 29259, 29277, 29285, and 29583.

29175 (ITEF–517) KVAZIKLASSICHESKOE PRIBLIZHENIE DLYA PEREMENNYKH POLEI. (Quasi-Classic Approximation for Alternating Fields). Popov, V. S.; Kuznetsov, V. P.; Perelomov, A. M. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1967. 67p. (In Russian). Dep.

The WKB approximation for the barrier penetrability is generalized for the case of time-dependent potentials. The penetrability calculation is reduced to the evaluating of sub-barrier "trajectory" formally satisfying classical mechanics equations and complex initial condition (the "time" t for the sub-barrier motion is imaginary). It is shown that the use of general formulae obtained for atom ionization in the strong light-wave-field allows one to simplify the calculations considerably. One formula was obtained for the probability of ionization of the bound state with the angular momentum l by the wave with arbitrary elliptic polar-

ization. The particle motion was studied in the high-frequency field ($\gamma = \omega/\omega_t \gg 1$, where ω is the oscillation frequency of the barrier, and ω_t is the tunneling frequency through an immovable barrier). Unlike the case of a constant field, the tunneling probability at $\gamma \gg 1$ is mainly defined by a small vicinity of the turning point. In this case, the frequency ω increasing, the effective width of the barrier decreases, resulting in the increase of penetrability. (auth)

29176 (JINR-E4-3760) SCATTERING OF LIGHT BY AN ELECTRON MOVING IN A REFRACTIVE MEDIUM. Frank, I. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics). 1968. 13p. Dep.

The scattering of light by an electron moving in a refractive medium is considered. It is shown that besides the normal scattering, when the incident photon is converted into the photon of the scattered light, another mechanism of scattering is possible — when the incident photon is not absorbed but gives rise to the photon of stimulated radiation and, in addition, the photon of the scattered light appears. The ratios are obtained, which connect the frequency of the initial light with that of the scattered light for both cases, i.e., for the normal and anomalous scattering. The condition is given for the frequencies of the two-photon Vavilov–Cherenkov effect. (auth)

29177 (LPTHE-TH-68/9) NOTE ON X-RAY SCATTERING BY ARGON. Levesque, Dominique; Verlet, Loup (Paris Univ., Orsay (France). Laboratoire de Physique Theorique et Hautes Energies). Mar. 1968. 6p. Dep.

The structure factor measured by x-ray scattering experiments on argon is compared with the same quantities calculated with two different intermolecular potentials. It is shown that it is not possible to get, from the scattering data, quantitative information concerning the interaction and that the discrepancy between theory and experiment is probably due to a systematic error in the latter. (auth)

29178 (ORNL-TM-2167) JACOBI-GAUSS QUADRATURE CALCULATIONS OF RYDBERG–KLEIN POTENTIAL ENERGY CURVES FOR DIATOMIC MOLECULES AND SOLUTIONS OF THE ENSUING WAVE EQUATIONS FOR SOME OF THEIR BOUND STATES. McKeever, J. W. (Oak Ridge Gaseous Diffusion Plant, Tenn.); Schweinler, H. C. (Oak Ridge National Lab., Tenn.). May 1968. Contract W-7405-eng-26. 170p. Dep. CFSTI.

Thesis. Submitted by H. C. Schweinler to Univ. of Tennessee, Knoxville.

A method, originally advanced by Rydberg and Klein, for calculating the potential energy for nuclear motion of a diatomic molecule by using the total energy as a function of the vibrational and rotational quantum numbers was integrated by Gaussian Jacobi numerical quadrature. Precision of 1 part in 10^7 was obtained, after an analytical correction, between the potential energies of two solvable problems and the potential energies calculated from the eigen energies of these problems using the Rydberg–Klein method. The computer program was used to obtain the potential energy of $H^{81}Br$ using a set of Dunham constants for this molecule, which had been measured by Rank, Fink, and Wiggins. Then the corrected potential energy curve, adjusted so that its minimum was zero, became input to the radial equation. The wave equation was solved for its eigen energies at states described by all pairs of vibrational quantum numbers 0, 1, 2, and 3 and rotational quantum numbers 0, 10, 20, and 30. The calculated eigen energies were between 0.1 and 0.2 cm^{-1} from the observed values. Of these calculated values only the energy eigenvalue for the (3,0) state was further from the observed value than was the value from the uncorrected potential input curve. The correction improved the calculated eigen energies from 0.03 cm^{-1} for the lowest energy states to 0.3 cm^{-1} for the highest energy states considered. (auth)

29179 (NP-tr-1639) VARIATION OF THE COMPOSITION OF AN ION BEAM FROM A HIGH FREQUENCY ION SOURCE OPERATING WITH HYDROGEN AT DIFFERENT PRESSURES. Devienne, F. Marcel; Roustan, J. C. Translated for Culham Lab., Abingdon, Eng., from Compt. Rend., Ser. A and B, 262: 616-19(Feb. 28, 1966). 5p. (CTO-452). Dep. CFSTI. UK. JCL $1.10 fs, $0.80 mf.

To investigate the percentage of H_3^+ as a function of the pressure in an ion source, a high-frequency source consisting of a cylindrical pyrex tube concentric with a coil connected to a high-frequency oscillator was used. One end carries the aluminum anode which is isolated from the plasma by an insulating disc. The gas is fed through a small duct located in the axis of the anode. The extraction of the ions at the other end of the tube is through an aluminium channel 11-mm long 3.2 mm in dia. insulated from the plasma by a silica cylinder. The pressure in the pyrex tube is measured with a Pirani gage which in the case of hydrogen is calibrated by means of a Macleod gage. To determine the percentage of the different ion types two different methods were used successively. (M.O.W.)

29180 (NP-tr-1638) DETERMINATION OF THE EXISTENCE AND OF CERTAIN SPECIAL PROPERTIES OF TRIATOMIC MOLECULAR HYDROGEN JETS. Devienne, F. M.; Roustan, J. C. Translated for Culham Lab., Abingdon, Eng., from Compt. Rend., Ser. A and B, 263: 1389-92(Dec. 19, 1966). 5p. (CTO-453). Dep. CFSTI. UK. JCL $1.10 fs, $0.80 mf.

Molecular jets with different properties are obtained by the charge exchange of H_1^+, H_2^+, H_3^+ ion beams. The accommodation coefficients with respect to silver and the variation of the gain of a photoscintillator demonstrate the existence of H_3^+ molecules. (auth)

29181 ELECTRIC-DIPOLE MOMENTS OF AN ATOM. I. SOME GENERAL CONSIDERATIONS. Sandars, P. G. H. (Oxford Univ.). J. Phys., B, 1: 499-510(May 1968).

The possible electric-dipole moments of an atom in a magnetic field are discussed. In order that the moment be nonzero, both parity and time-reversal invariance must be violated. The usual proof for this is not strictly valid in the presence of a magnetic field, and an alternative proof is given, which does not suffer this disadvantage. The various forms that a violation of parity and time-reversal invariance can take are identified, and an effective dipole operator is constructed to reproduce the resulting electric-dipole moments within a given hyperfine structure multiplet. With plausible assumptions it is shown that this effective operator depends on only a small number of parameters. In order to bring out the symmetry of the problem, these parameters are chosen to be the coefficients in a spherical tensor expansion of the effective dipole operator. This expansion is then used to derive expressions that give the dipole moment for any state in a given hyperfine structure multiplet of a $J = \frac{1}{2}$ atom, at any magnetic field. (auth) (UK)

29182 ELECTRIC-DIPOLE MOMENTS OF AN ATOM. II. THE CONTRIBUTION FROM AN ELECTRIC-DIPOLE MOMENT ON THE ELECTRON WITH PARTICULAR REFERENCE TO THE HYDROGEN ATOM. Sandars, P. G. H. (Oxford Univ.). J. Phys., B, 1: 511-20(May 1968).

A quantitative calculation is made of the electric-dipole moment on a free one-electron atom, which would result from the existence of a nonzero moment on the electron. It is shown that in the nonrelativistic approximation the atomic moment is zero, but that relativistic effects allow a nonzero value. For the ground state of hydrogen the atomic moment is found to be $-2Z^2\alpha^2 d_e$, while for the 2s state it is of order d_e/α (d_e is the electron moment and α is the fine-structure constant). The enhancement in the 2s state is closely connected with the near degeneracy of the 2s and 2p states. (auth)

29183 ELECTRON COLLISION CROSS SECTIONS FOR THE $2l_0 \rightarrow 3l$ TRANSITIONS IN HYDROGEN. Van Blerkom, Janet (Joint Inst. for Laboratory Astrophysics, Boulder, Colo.). J. Phys., B, 1: 423-7(May 1968).

The collisional cross sections for the excitation of a hydrogen atom from the 2p and 2s states to the 3s, 3p, and 3d states are calculated in the approximation proposed by Morrison and Rudge [Proc. Phys. Soc., 89: 45-53(1966); ibid., 91: 565-73(1967)]. A comparison is made with the close-coupling calculations of Burke, Ormonde, and Whitaker, and with the dipole approximation calculations of Saraph. It is found that the Morrison and Rudge approximation does not give reliable results for the $2l_0 \rightarrow 3l$ transitions. (auth) (UK)

29184 IMPORTANCE OF CORRELATION IN THE EVALUATION OF BORN CROSS SECTIONS. Kennedy, D. J. (Queen's Univ., Belfast). J. Phys., B, 1: 526-8(May 1968).

Generalized oscillator strengths for the $1\,^1S-2\,^1S$ and $1\,^1S-3\,^1S$ transitions in atomic helium were calculated using many-parameter correlated orthogonal wave functions. The scattering amplitude for elastic scattering was also evaluated. From these values the Born cross sections for electron scattering were obtained. There is good agreement between these results and those found using Hartree–Fock wave functions. (auth) (UK)

29185 INTEGRAL EQUATION APPROACH TO ELECTRON–HYDROGEN COLLISIONS. Sloan, I. H.; Moore, E. J. (Univ. of New South Wales, Kensington). J. Phys., B, 1: 414-22(May 1968).

A recent formulation of the three-body collision problem in the form of coupled multichannel two-body Lippmann–Schwinger equations is applied to the electron–hydrogen collision problem. The relation between these equations and the close-coupling equations is studied by casting the latter into integral form. A simple

high-energy approximation, which amounts to a unitary version of the Born–Oppenheimer approximation, is derived and used in its simplest form to calculate elastic scattering. The results indicate that exchange effects and unitarity corrections are significant at least up to 400 eV. (auth) (UK)

29186 MOBILITY OF He^+ IONS IN He. Dickinson, A. S. (Queen's Univ., Belfast). J. Phys., B, 1: 387-94(May 1968).

The total, charge-transfer, diffusion, and viscosity cross sections for He^+ in He are calculated using numerically integrated phase shifts and term-by-term summations. The calculated mobility is in harmony with recent measurements. The corrections to the usual mobility expression are evaluated and found to be negligible. The average behavior of the total cross section is satisfactorily described by the Schiff–Landau–Lifshitz approximation. (auth) (UK)

29187 PROTON–HYDROGEN SCATTERING WITH VARIABLE EFFECTIVE CHARGE. Cheshire, I. M. (Atomic Energy Research Establishment, Harwell, Eng.). J. Phys., B, 1: 428-37 (May 1968).

Coupled-channel calculations are performed for proton–hydrogen scattering using an expansion in atomic orbits in which the effective charge seen by each orbital is allowed to vary with time. It is shown that optimum charges are determined by an Euler–Lagrange equation. At very low energies the method closely resembles an expansion in molecular orbitals, and the Euler–Lagrange equation minimizes the molecular energies. By comparison with previous calculations that use molecular and atomic expansions it is shown how the method bridges the gap between them. Excellent agreement is obtained with the oscillating probability measurement of Lockwood and Everhart for charge exchange at 3°. Cross sections are calculated at 25 keV and compared with experiment and other theories. (auth) (UK)

29188 RESONANCES AND EXCHANGE IN THE SCATTERING OF ELECTRONS BY HELIUM ATOMS. I. PRODUCT WAVE FUNCTION FOR THE HELIUM ATOM. Herzenberg, A.; Lau, H. S. M. (Univ. of Manchester, Eng.). J. Phys., B, 1: 327-35 (May 1968).

The elastic scattering of electrons is calculated with a Hylleraas product wave function for the target atom and with neglect of polarization. A narrow resonance is found at an incident kinetic energy of 4.2 eV, provided that the exchange operator is changed slightly from the value corresponding to the no-polarization approximation, by multiplying by a constant factor differing from unity by plus or minus a few percent. (auth) (UK)

29189 RESONANCES AND EXCHANGE IN THE SCATTERING OF ELECTRONS BY HELIUM ATOMS. II. CORRELATED HELIUM WAVE FUNCTION. Herzenberg, A.; Lau, H. S. M. (Univ. of Manchester, Eng.). J. Phys., B, 1: 336-48(May 1968).

The elastic scattering of electrons by helium atoms is calculated with a target wave function containing some correlation. Polarization is simulated by the addition of a small attractive potential. A resonance is found at an energy that is extremely sensitive to the magnitude of the polarization. The resonant wave function has one electron in the 1s level, and the other two in the correlation component (orthogonal to $(1s)^2$) of the helium ground state. The treatment shows that such a resonance should always be found in a one-channel calculation with a target wave function containing some correlation. It is pointed out, however, that the customary approximations are of very dubious validity at the resonance. (auth) (UK)

29190 TRANSPOSITION OF THE THEORY OF SUPERCONDUCTIVITY TO ATOMIC AND MOLECULAR SYSTEMS. BIORBITAL METHOD. Durand, Philippe. Cah. Phys., No. 204, 285-332(Aug. 1967). (In French).

It has been shown that identical bielectron orbitals can be used to construct the wave functions of normally atomic or molecular systems. A systematic study is made of these pair functions. A review is given of the pair functions and their applications to atoms and molecules. The biorbital functions themselves are then studied. The energy expressions and the variational equations are then given. An application to the Be atom is given. The characteristics of the biorbital method are then given. A comparison is made between this method and the traditional methods. (J.S.R.)

29191 ON THE RATE OF FUSION REACTION IN MESIC MOLECULE $dd\mu$ WITH MOMENTUM 1. Vesman, E. (Inst. of Physics and Astronomy, Tallin, USSR). Izv. Akad. Nauk Est. SSR, Fiz. Mat., 17: 65-71(1968). (In Russian).

In an earlier work the author has shown that the most probable mechanism of formation of the mesic molecular ion $(dd\mu)^+$ gives the ion in a metastable P state. Consequently the fusion reactions observed in experiments must occur in a P state. It is well known that the products of the fusion reaction in case of the reaction d + d in flight have an angular distribution even at very low energies. The angular distribution is due to a high P-wave contribution to the cross section of the reaction. The constant of the reaction in a P state (3.5) is based on experimental data. This constant is used to calculate the rate of the fusion in the mesic molecule $(dd\mu)^+$ in a P state. It is found that the formation of this molecule is practically always accompanied by fusion. The rate of the fusion in $(dd\mu)^+$ is almost the same in S and P states and is of order 10^{10} sec^{-1}. (auth)

29192 REGARD FOR RADIAL DEPENDENCE OF THE EFFECTIVE CHARGES IN THE TWO-ELECTRON ATOMS. Kruglyak, Yu. A.; Dolgushin, M. D. (Inst. of Physical Chemistry, Kiev). Liet. Fiz. Rinkinys, Liet. TSR Mokslu Akad., Liet. TSR Aukst. Mokyklos, 7: 329-40(1967). (In Russian).

It is known that the angular dependence of the effective charge corresponds to the partial account for configuration interaction in the MO-LCAO scheme. For consideration of radial dependence, a new biexponential function ψ_α of unseparable variables and with correct asymptotics at the nucleus is suggested. Numerical results are given for the energy and its components, for the ground state of the two-electron atoms (Z = 2, 3, . . . , 10) computed with the function ψ_α, and the function ψ_β written in the one-electron approximation. Also, the distribution of the radial electron density, charge, and potential, and diamagnetic susceptibility for the ground state of the He atom computed with the simple function ψ_χ and with two biexponential functions ψ_α and ψ_β are given, taking into account analytically the radial dependence of the effective charge. (auth)

29193 METHODS OF DATA REDUCTION IN ANALYZING POSITRON ANNIHILATION LIFETIME SPECTRA. Tao, S. J. (New England Inst. for Medical Research, Ridgefield, Conn.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: 175-87(Feb. 1968). (NYO-3661-7).

From 14th Nuclear Science Symposium, Los Angeles. See CONF-671026.

The methods of data reduction used in processing the positron annihilation lifetime spectra are thoroughly discussed. For curves which are believed to represent a multi-exponential scheme the method of least squares is still found to be the most useful one. Its convergence properties, the confidence level of its result and the effect of instrument noise to the result are also discussed. The method of Fourier transforms can also provide reasonable answers, however, its precision is quite limited. For curves which do not appear as multiexponentials the calculation of time-dependent annihilation rate $\lambda(t)$ is one of the simplest methods. A direct calculation of energy-dependent annihilation rate $\lambda(E)$, or cross section, in general, is not possible since diffusion approximation is not always applicable and our knowledge in the scattering process is quite limited. However, in inert gases, without strong annihilation, a fair estimate of $\lambda(E)$ may be obtained after certain approximations are made. (auth)

29194 SPIN RADIATION. Urbanovich, S. I. (Academy of Sciences, Minsk). Dokl. Akad. Nauk BSSR, 11: 24-7(Jan. 1967). (In Russian).

The possibility of changing the orientation of the proton magnetic moment in hydrogen molecules by means of an external field was examined. At low temperatures the ortho state of hydrogen is unstable and transforms into the para state but because of weak interactions, this transformation is extremely slow. In an external magnetic field, the behavior of hydrogen molecules depends on their interaction with the field; since the rate of transformation is proportional with the changes of the magnetic field as a function of distance, the protons must be located in different local fields with respect to either the field strength or direction. By estimating the transformation probability within unit time, the difference between the field strengths at the two proton locations was calculated to be about 10^2 gauss; for interatomic distances, the field in paramagnetic molecules is about 10^3 gauss. Thus, for sufficiently active absorbing surfaces, it is possible to transform a large number of hydrogen molecules from the ortho to the para state. The orientation of proton magnetic moments coincides with the orientation of the spin vector; thus a surface in contact with ortho hydrogen can become a source of monochromatic spin radiation. (TTT)

29195 USE OF COULOMB GREEN FUNCTION IN ATOMIC PERTURBATION THEORY. Greiser, A. I.; Tolmachev, V. V. (Inst. of Physical Chemistry, Moscow). Teor. Eksp. Khim., 4: 165-70(Mar.-Apr. 1968). (In Russian).

The Coulomb Green function for negative energy values was used for calculating the second-order sums and integrals appearing in atomic field theory. (tr-auth)

29196 EFFECT OF THERMAL LATTICE OSCILLATIONS ON THE ANISOTROPY OF THE SPUTTERING COEFFICIENT AND OF THE ION-ELECTRON EMISSION COEFFICIENT OF SINGLE CRYSTALS. Evdokimov, I. N.; Molchanov, V. A.; Odintsov, D. D.; Chicherov, V. M. (Univ., Moscow). Dokl. Akad. Nauk SSSR, 177: 550-3(Nov. 21, 1967). (In Russian).

Sputtering is a cascade process, which begins when an incident ion strikes a target atom and imparts part of its energy to the atom. Then the atom moves in the lattice and forms displaced atoms on its way. Part of the displaced atoms reach the surface and leave the target. This sputtering mechanism is called a diffusion mechanism. Another sputtering mechanism is the focuson mechanism, where the collision energy is carried to the surface by a succession of focused collisions (focusons). Useful information on both mechanisms can be obtained by a relative experimental study of the temperature dependencies of sputtering and ion-electron emission of single crystals. The (110) and (111) edges of a Cu crystal were irradiated with 30-MeV argon ions, and the sputtering coefficients S and ion-electron coefficient γ were determined as a function of temperature and incident angle. The sputtering coefficient S decreased with increasing temperature up to 750 to 850°C at all incident angles. The value of γ decreased more slowly than the value of S. It is calculated that the change in crystal transparency due to increase in amplitude of thermal vibrations, defect annealing, etc., had an effect on the sputtering and the electron emission that was in agreement with the experimental results. (TTT)

29197 ELECTRIC DIPOLE HYPERPOLARIZABILITIES FOR SEVERAL OPEN SHELLS OF ELECTRON SYSTEMS. Malinowski, S. (Univ. of Lodz, Poland). Acta Phys. Pol., 33: 401-7 (Mar. 1968).

A method is derived for calculating the electric dipole hyperpolarizabilities on the case of open shells of atoms and ions by means of coupled first- and second-order Roothaan–Hartree–Fock orbital equations. A second method is also given, which involves the direct calculation of the Roothaan–Hartree–Fock wave functions of the atoms and ions, for open-shell electron systems, in the presence of a constant perturbing field. (auth)

29198 REMARKS ON WALLACE'S HAMILTONIAN PERTURBATION METHOD. Zietek, W. J. (Univ. of Wroclaw). Acta Phys. Pol., 33: 449-54(Mar. 1968).

The statistical part of Wallace's Hamiltonian perturbation method worked out for the occupation number representation is here formulated without reference to any particular representation and augmented by a formula for calculating statistical averages to order m + 1 if the problem is solved to order m. Furthermore, two erroneous statements made previously are pointed out and discussed. (auth)

29199 ON THE MEASUREMENT OF TOTAL ATTENUATION COEFFICIENTS OF X-RAYS BELOW THE K-ABSORPTION EDGE IN DIFFERENT ELEMENTS. Ghumman, B. S.; Sood, B. S. (Punjabi Univ., Patiola, India). Curr. Sci. (India), 37: 250(May 5, 1968).

A method to determine the total attenuation coefficients of x rays just below the K-absorption edge in various elements was developed. It was used to measure the absorption coefficients of the K-shell characteristic x rays of lead, gold, tungsten, tin, and silver. Various thicknesses of the target were irradiated with low-energy γ radiation, and the K-shell x radiation as a function of target thickness was measured. (J.G.B.)

29200 SOME NEW TRANSITIONS IN THE L EMISSION SPECTRUM OF ERBIUM. Deodhar, G. B.; Singh, R. B.; Varma, P. P. (Univ. of Allahabad, India). Can. J. Phys., 46: 939-41(Apr. 15, 1968).

A systematic study of the L spectrum of erbium with a 40-cm curved mica crystal spectrograph showed the existence of two new dipole transitions, $L_{II}O_I(\gamma_8)$ λ1343.50 x.u. and $L_{III}N_{IV}(\beta_{15})$ λ1512.74 x.u., and three new forbidden transitions, L_IO_I λ1276.81 x.u., $L_IO_{IV,V}$ λ1268.68 x.u., and $L_{II}O_{II,III}$ λ1339.81 x.u. The transitions $L_{II}O_{IV}(\gamma_6)$ and $L_{III}O_{IV,V}(\beta_5)$ reported earlier only by Sakellaridis have been confirmed. However, the transition $L_IM_V(\beta_9)$ reported only by Coster remained unconfirmed. (auth)

29201 THE PHOTOIONIZATION ABSORPTION CONTINUA FOR ALKALI METAL VAPOURS. Marr, G. V.; Creek, D. M. (Univ. of Reading, Eng.). Proc. Roy. Soc. (London), Ser. A, 304: 233-44(Apr. 16, 1968).

Absorption measurements are reported for the metal vapors of potassium, rubidium and caesium, and existing data for lithium and sodium are reviewed. The separation of atomic and molecular absorption is discussed, and the data presented as absolute cross-section curves as a function of wavelength. The shapes of the atomic photoionization continua and their absolute values are discussed in relation to theoretical cross-section data. Best experimental values of the cross sections at the series limits are found to be: Li = 1.9 ± 0.2 Mb, Na = 0.125 ± 0.01 Mb, K = 0.007 ± 0.002 Mb, Rb = 0.10 ± 0.015 Mb and Cs = 0.20 ± 0.03 Mb. The curves for potassium, rubidium and caesium have non-zero minima and that for sodium has a minimum which is near zero. Experimental minimum values of $4 \pm 2 \times 10^{-3}$ Mb, $8 \pm 3 \times 10^{-3}$ Mb and $6 \pm 1 \times 10^{-2}$ Mb for potassium, rubidium and caesium, respectively, are obtained. (auth) (UK)

29202 PRODUCTION OF HIGH-ENERGY POLARIZED GAMMA-RAYS FROM AN ELECTRON SYNCHROTRON WITH AMORPHOUS RADIATOR. Sasaki, H. (Tokyo Univ.); Takamatsu, K.; Iwata, S.; Ito, H.; Wakuta, Y.; Horikoshi, G. Nucl. Instrum. Methods, 62: 45-50(June 1, 1968).

It has been tried to obtain high-energy polarized gamma rays from a synchrotron with an amorphous radiator. As a radiator a nylon monofilament, 60 μm in dia., was used. The polarization of the photon beam was determined by comparing the angular distribution of the pair electrons produced by the polarized photon beam with that produced by the unpolarized one. The angular distribution of the pair electrons was observed with a wire spark chamber. The degree of the photon polarization was measured at various incident electron- and photon energies and the emission angles of the photon beam, and for different accelerating rf conditions of the synchrotron. (auth)

29203 ELECTRODYNAMICS OF MOVING MEDIA AND THE CHERENKOV RADIATION. Sen Gupta, N. D. (Tata Inst. of Fundamental Research, Bombay). J. Phys. A, 1: 340-9(May 1968).

The object of the study described is to find the equations for the electric and magnetic intensities E and H in a homogeneous medium moving with a uniform velocity, from Maxwell's field equations and Minkowski's material relations. The nature of the solution of these equations in general is studied. An alternative approach is suggested, to reduce the problem to a mathematically equivalent problem in empty space. This is done by introducing linear space–time transformations similar to the Lorentz transformations. As an application, the Cherenkov radiation is studied. By suitable transformation this is reduced to a problem equivalent to antenna radiation. The special case of motion with velocity equal to the phase velocity, which has unusual consequences, is also treated. (auth)

29204 CHARACTERISTIC ENERGY LOSSES OF ELECTRONS IN SOME ALKALI HALIDES: BAND STRUCTURE AND PLASMONS. Gout, C.; Pradal, F. (CNRS, Toulouse, France). J. Phys. Chem. Solids, 29: 581-92(Apr. 1968). (In French).

The characteristic energy losses of electrons were measured in the following alkali-metal halides: KCl, KBr, NaCl, NaBr, LiCl, LiF, NaF, KF. These experiments make possible the determination of the plasmon excitation energy and of some band parameters when a theoretical model of band structure is available. This is the case for KCl. For the other crystals the measurements carried out lead to a proposal of a model of band structure. The results complement those deduced from optical data, especially in the domain of great energies. (auth) (UK)

29205 BREMSSTRAHLUNG PRODUCED IN THICK ALUMINUM AND IRON TARGETS BY 0.5 TO 2.8-MeV ELECTRONS. Dance, W. E. (Ling-Temco-Vought, Inc., Dallas); Rester, D. H.; Farmer, B. J.; Johnson, J. H.; Baggerly, L. L. J. Appl. Phys., 39: 2881-9(May 1968).

The bremsstrahlung produced by electrons with incident energies of 0.5, 1.0, 2.0, and 2.8 MeV bombarding aluminum and iron targets of sufficient thickness to stop the electrons, has been measured. Spectral distributions of external bremsstrahlung intensity per unit solid angle, at representative emission angles ranging from 0 to 150 deg are presented graphically. Spectral distributions of radiation energy integrated over all angles and integrated over only the forward hemisphere are presented. Plots of total intensity as a function of angle show the degree of peaking in the forward direction with increasing electron energy. Total external radiation energy is found to vary as the square of the bombarding electron energy T_0 over this energy range. The external efficiency for bremsstrahlung production is found to be $4.8 \times 10^{-3}\ T_0$ for Al and $9.2 \times 10^{-3}\ T_0$ for Fe, where T_0 is in MeV. (auth)

29206 INVESTIGATION OF RESONANCE-LINE SCATTERING BY THE MONTE CARLO TECHNIQUE. Avery, Lorne W.; House, Lewis L. (High Altitude Observatory, Boulder, Colo.). Astrophys. J., 152: 493-507(May 1968).

The problem of photon diffusion through a purely scattering atmosphere is investigated by means of the Monte Carlo technique for two types of scattering: (1) complete redistribution

and (2) coherent scattering in the rest frame of the atom which leads to partially coherent scattering in the external frame. The Monte Carlo techniques are applied to Lyman-α photons generated at a point source at the center of a plane-parallel slab of large optical thickness. The mean number of scatterings requircd for escape, $\langle N \rangle$, is computed for both types of scattering. For thick slabs $\langle N \rangle$ is found to be much greater under partially coherent conditions. As a result the source function should approach the equilibrium value at smaller optical depths than one predicts under complete redistribution. In addition it is found that, under partially coherent scattering, photons tend to diffuse more easily in space, but less easily in frequency than under complete redistribution. Thus for complete redistribution the photons are more likely to remain in the vicinity of their origin until they escape from the atmosphere as the result of a single, large frequency shift. (auth)

29207 gf-VALUES OF ULTRAVIOLET Fe I, Cr I, AND Cr II LINES FROM SHOCK-TUBE MEASUREMENTS. Huber, Martin; Tobey, Frank L. Jr. (Harvard Coll. Observatory, Cambridge, Mass.). Astrophys. J., 152: 609-20(May 1968).

Absolute experimental gf-values are reported for 38 Fe I, 5 Cr I, and 2 Cr II lines lying between 3150 and 3780 Å. The oscillator strengths were obtained by flash absorption spectroscopy on a pressure-driven shock tube. The results show disagreements with gf-values of Corliss and others (arc measurements) on the absolute scale and with lines which have an upper excitation potential exceeding 48000 cm^{-1} on the relative scale. The latter discrepancy is attributed to a partially erroneous normalization function used in the previous measurements on an open arc. Errors in the absolute scale due to the shock-tube measurements were ruled out as unlikely. The influence of shock emission and line broadening on the measurements is described. Other investigations supporting the shock-tube measurements are cited, and it is suggested that the absolute scale of the arc measurements in the near-ultraviolet be lowered considerably. (auth)

29208 CROSS SECTIONS FOR THE ABSORPTION OF X RAYS BY URANIUM AND THORIUM. Bezdenezhnykh, G. V.; Zapysov, A. L.; Israilev, I. M.; Saprykin, V. N. Opt. Spectrosc. (USSR) (Engl. Transl.), 23: 533(Dec. 1967).

Translated from Opt. Spektrosk., 23: 880-1(Dec. 1967).

Total absorption cross sections for the passage of x rays through uranium and thorium layers were measured. Incident x-ray energies ranged from 3.1 to 26 keV. (M.O.W.)

29209 POLARIZATION OF FIELD-EMITTED ELECTRONS FROM GADOLINIUM IN HIGH MAGNETIC FIELDS. Chrobok, G.; Hofmann, M.; Regenfus, G. (Univ., Munich). Phys. Lett., 26A: 551-2(Apr. 22, 1968).

At 85°K the spin polarization of field-emitted electrons from polycrystalline Gd was measured as a function of external magnetic fields up to 55 kG. The P(H) values obtained can be explained with the electronic band structure of Gd at the Fermi edge and with an exchange splitting of about 0.8 eV. (auth)

29210 EXTENDED METHOD AND MANY-CONFIGURATIONS APPROXIMATION IN THE THEORY OF ELECTRON-ATOM COLLISIONS. Lyash, A. V.; Bolotin, A. B. (Kapsukas State Univ., Vilnyus, USSR). Liet. Fiz. Rinkinys, Liet. TSR Mokslu Akad., Liet. TSR Aukst. Mokyklos, 7: 341-60(1967). (In Russian).

The cross sections of the excitations of the helium atom and helium-like ions from Li^+ to O^{+6} in Born's approximation were calculated. The analytic wave functions were applied. For the ground state of the helium atom and helium-like ions the hydrogen-like wave functions with the different effective charge α were used. Their magnitude was calculated by the ordinary and extended method of calculation. For the excited states, hydrogen-like wave functions and those of many-configuration approximation were used. It was found that the cross sections of the excitations are very sensitive to the values of α and wave functions of the excited states. (auth)

29211 TWO-PHOTON BOUND STATE–BOUND STATE TRANSITIONS IN A COULOMB FIELD. Rapoport, L. P.; Zon, B. A. (Voronezh State Univ., USSR). Phys. Lett., 26A: 564-5 (Apr. 22, 1968).

Expressions are given for various two-photon transitions. (auth)

29212 EXCITATION OF TWO ATOMS BY A SINGLE PHOTON. Mittleman, M. H. (Univ. of California, Berkeley). Phys. Lett., 26A: 612-13(May 6, 1968).

A pair of ground state atoms can absorb a single photon resulting in two excited atoms if the absorption takes place during a collision of the atoms. A crude illustrative calculation for a He gas is outlined. (auth)

29213 STRUCTURE OF THE SECONDARY ELECTRON ENERGY SPECTRA. Evdokimov, I. N.; Molchanov, V. A. (Moscow State Univ.). Phys. Lett., 26A: 636-7(May 6, 1968).

The low-energy part of the energy distribution of secondary electrons ejected from metal targets by fast noble gas ions, showed a fine structure, represented by a number of narrow maxima and minima. (auth)

29214 PENETRATION DEPTH AND DISTRIBUTION OF LOW-ENERGY IONS IN SOLIDS. Kessel'man, V. S. Fiz. Tekh. Poluprov., 2: 93-101(Jan. 1968). (In Russian).

The results of a Monte Carlo calculation of the range of atoms (ions) in solids (principally Ge and Si) in a wide range of the mass of the bombarding ions are reported. In the accepted models it is considered that the moving atom loses energy as a result of the elastic and inelastic collisions with the atoms of the target. Three types of potentials of the interatomic interactions are used in the calculation: the screening Coulomb potential (Bohr potential), Thomas–Fermi potential and Thomas–Fermi–Dirac potential. Relations used for the evaluation of the energy loss of ions in inelastic collisions (electron bremsstrahlung), energy limitation of the use of the Thomas–Fermi potential, and collision models of the solid-sphere type with energy-dependent radius of the sphere are obtained. The analytical expression for the distribution of the incident atoms (ions at the penetration depth in the solid was derived. The calculation results were compared with known experimental data. (tr-auth)

29215 CHARACTERISTIC X-RAY PRODUCTION FROM METALS BY 90-keV Ar^+-ION BOMBARDMENT. Saris, F. W.; van der Weg, W. F.; Kistemaker, J. (FOM-Instituut voor Atoom- en Molecuulfysica, Amsterdam). Phys. Lett., 26A: 592-3(May 6, 1968).

Soft x-rays are observed during bombardment of metal surfaces with 90-keV Ar^+ ions. The wavelength involved is correlated to the inelastic energy loss during the ion–atom collision. (auth)

29216 CROSS SECTIONS FOR STEPWISE EXCITATION AND QUENCHING PROCESSES IN THE $2p^5nd$ AND $2p^5np$ CONFIGURATIONS OF NEON. Krivchenkova, V. S.; Khakhaev, A. D. Opt. Spectrosc. (USSR) (Engl. Transl.), 23: 473-4(Dec. 1967).

Translated from Opt. Spektrosk., 23: 865-7(Dec. 1967).

Cross sections are determined for the stepwise excitation of levels of the electron configurations $2p^5nd$ (n = 3, 4, 5, 6, 7, 8) and $2p^5np$ (n = 3, 4, 5, 6, 7). The parameters of the quenching processes of these levels are found. The dependence of the parameters on the principal and azimuthal quantum numbers is shown. (auth)

29217 CONCERNING ONE METHOD OF DETERMINING THE EFFECTIVE PROBABILITY OF PHOTON EMISSION BY ATOMS. Abramov, V. A.; Kogan, V. I. Opt. Spectrosc. (USSR) (Engl. Transl.), 23: 466-7(Dec. 1967).

Translated from Opt. Spektrosk., 23: 851-3(Dec. 1967).

The accuracy of the method proposed earlier for determining the effective probability of photon emission by atoms (A_{eff}) is analyzed. It is shown that the quantities A_{eff}^{exp} and A_{eff}^{theor} that are involved in this method can in general differ greatly from each other, but this, on the other hand, makes it possible to extend the capabilities of the method. (auth)

29218 A DETERMINATION OF THE EFFECTIVE CROSS SECTIONS FOR EXCITATION AND DECAY OF THE UPPER LEVELS OF HELIUM, NEON, AND ARGON IN A HIGH-FREQUENCY DISCHARGE. Razumovskaya, L. P. Opt. Spectrosc. (USSR) (Engl. Transl.), 23: 463-5(Dec. 1967).

Translated from Opt. Spektrosk., 23: 845-50(Dec. 1967).

The mechanism of excitation of the upper levels of helium, neon, and argon is discussed. The balance equation of the number of excitations and decays of levels per unit time and the experimental dependences of the level population, electron temperature, and electron concentration on the discharge conditions (gas pressure and hf voltage on the electrodes of the discharge tube) were used to explain this mechanism. A simple graphical method using experimental curves is proposed for finding the effective cross sections for the stepwise excitation and decay of levels by collisions with atoms. Cross sections were determined by this method for levels with the main quantum numbers n = 3–8 for He, n = 3 for Ne, and n = 5 for Ar. (auth)

29219 RULES GOVERNING THE POPULATION OF CLOSE-LYING ATOMIC LEVELS IN A GAS DISCHARGE. Pavlovskaya, E. N.; Podmoshenskii, I. V. Opt. Spectrosc. (USSR) (Engl. Transl.), 23: 477-9(Dec. 1967).

Translated from Opt. Spektrosk., 23: 873-7(Dec. 1967).

It is shown experimentally that the distribution of the population of the upper levels of lines forming multiplets in a hollow cathode,

a high frequency discharge, and the positive column of a glow discharge at $p > 1$ mm is determined by the temperature of the gas atoms. The effective cross section for the excitation of close-lying levels with $\Delta E < 0.1$ eV by atomic collision is estimated at $\sigma_a \approx 3$ to 5×10^{-15} cm^2. (auth)

29220 EFFECTIVE CROSS SECTION OF THE SECOND-ORDER COLLISIONS OF MERCURY AND ZINC ATOMS. Sosinskii, M. L.; Morozov, E. N. Opt. Spectrosc. (USSR) (Engl. Transl.), 23: 475-7(Dec. 1967).

Translated from Opt. Spektrosk., 23: 868-72(Dec. 1967).

Measurements were made of the effective cross section of second order collisions of mercury atoms in the 6^3P_1 state and zinc atoms in the ground state 4^1S_0. The determination of the effective cross section was made according to the relative intensity of the fluorescence lines Hg 2537 and Zn 3076 Å. Also, the method of determining the effective cross sections of second order collisions was improved and investigations were performed over a wide range of vapor pressures of zinc and mercury. (auth)

29221 APPLICATIONS OF FOURIER TRANSFORM SPECTROSCOPY TO STUDIES OF LINE PROFILES. Cook, A. H. (National Physical Lab., Teddington, Eng.). Mon. Notic. Roy. Astron. Soc., 139: 141-54(1968).

The principles of the study of line profiles by Fourier transform methods are summarized, and examples of applications to emission profiles are discussed, astrophysical problems being emphasized. Absorption lines are less easy to investigate by Fourier transform methods, but there may be special problems to which Fourier transform methods could profitably be applied. (auth) (UK)

29222 RADIO-FREQUENCY SPECTRUM OF H_2^+. Somerville, W. B. (London Univ.). Mon. Notic. Roy. Astron. Soc., 139: 163-73(1968).

New calculations are reported for the hyperfine structure of the ground state of the hydrogen molecular ion. First-order coefficients were obtained to an improved accuracy; computational problems are discussed and discrepancies among previous calculations are analysed. Recent experimental work by Richardson, Jefferts, and Dehmelt enables the contribution of second-order effects to be determined, and the final transition frequencies are accurate to better than 1 MHz. The principal frequencies of transition and the corresponding A coefficients are

MHz	$A(10^{-15}s^{-1})$
1414.2	1.75
1399.6	3.63
1398.7	1.91
1321.6	0.40
1306.0	2.78

The equilibrium interstellar abundance of H_2^+ is expected to be small, but these radiations may be detectable in observations of disturbed regions. (auth) (UK)

29223 AUGER ELECTRON EMISSION FROM CLEAN Mo BOMBARDED BY POSITIVE IONS. III. EFFECT OF ELECTRONICALLY EXCITED IONS. Vance, Dennis W. (Xerox Corp., Rochester, N. Y.). Phys. Rev., 169: 263-72(May 10, 1968).

Measurements of the effect of electronic excitation of the incident ions on Auger electron emission yield from clean molybdenum surfaces are reported. The influence of excited ions in the beam used in these measurements is studied by observing the variation in the measured Auger yield γ_i with the energy of the electrons used to produce the ions in the electron bombardment ion source. The species O_2^+, NO^+, N_2^+, N^+, and H_2^+ were studied. Of these, only the O_2^+ and NO^+ beams were found to contain electronically excited ions at a time ~20 μsec after their formation. By operating the ion source at an electron energy below the threshold of the first excited state, a pure ground-state ion beam is produced. The electron yield for these ground-state ions bombarding an atomically clean molybdenum surface is reported over the range of ion kinetic energies from 30 to 400 eV. Methods of estimating the excited-state population in an ion beam are discussed and compared with one another. It is argued that in the present case, only a single excited state is present in the O_2^+ and NO^+ beams, allowing an estimate of the excited-state electron yield to be made. The implications of these results with respect to previous measurements of electron yields in which excited states were not considered are discussed. (auth)

29224 AUGER ELECTRON EMISSION FROM CLEAN Mo BOMBARDED BY POSITIVE IONS. II. EFFECT OF ANGLE OF INCIDENCE. Vance, Dennis W. (Xerox Corp., Rochester, N. Y.). Phys. Rev., 169: 252-62(May 10, 1968).

Values are reported for the number of electrons ejected from a polycrystalline molybdenum target bombarded by mass-selected beams of the positive ions, He^+, Ne^+, Ar^+, N_2^+, N^+, H_2^+, and NO^+. Measurements were made over the range of ion kinetic energies from 30 to 400 eV. Experiments were conducted in an ultrahigh vacuum system with particular attention paid to producing an atomically clean and smooth target surface. The variation of the electron yield γ_i (electrons/ion) with angle of incidence of the ion beam was studied. It was found that the yield varied smoothly over the range of angle of incidence from 0 to 60°, although the sense of the variation (i.e., increase or decrease) was different for different ions. The dependence of γ_i on angle of incidence is discussed in terms of the existing models of kinetic and potential (or Auger) electron emission. The experimental data at low ion kinetic energies is quantitatively explained by assuming that all the ions are Auger-neutralized before reaching the surface. At the high ion kinetic energies, it appears that some non-Auger processes are occurring in which the ion produces secondary electrons within the metal lattice. The variation of the electron yield with angle of incidence for He^+ bombarding a heavily contaminated tungsten surface is also reported and compared with Oliphant's early results. (auth)

29225 TOTAL IONIZATION AND RANGE OF LOW-ENERGY RECOIL PARTICLES IN PURE AND BINARY GASES. Cano, Gilbert L. (Sandia Lab., Albuquerque, N. Mex.). Phys. Rev., 169: 277-80(May 10, 1968).

The total ionization and range of the 103-keV ^{206}Pb recoil particle that results from the α decay of ^{210}Po deposited on a metallic backing have been determined for a number of gases. The method employed a hemispherical ion chamber and a vibrating-reed electrometer. The 5.3-MeV α particles were used for calibration. The gases used were Ne, Ar, Xe, N_2, dry air, CH_4, C_2H_4, 95% Ar + 5% C_2H_4, and other binary mixtures. The equivalent ranges, in microns, of the ^{206}Pb particle in the listed gases at STP are 131, 79, 44, 80, 83, 84, 58, and 82, respectively. The uncertainty in each value is ±2 μ. The average energy loss per ion pair produced, W_r, in eV/(ion pair), for the ^{206}Pb particle in passing through the gases, omitting Ne, is 121 ± 6, 158 ± 8, 116 ± 6, 120 ± 6, 121 ± 6, 115 ± 4, and 81.7 ± 2, respectively. Theory and experiment for the range of the ^{206}Pb particle in the monatomic gases lie within 5% of each other. A rough calculation is made of the energy the recoil particle loses through molecular, nonionizing processes per ion pair produced. For N_2 this amounts to approximately 10 eV/(ion pair) of the W_r value. (auth)

29226 MAGNETIC-INTERACTION INTEGRALS FOR Pa II. Wilson, M. (Argonne National Lab., Ill.). J. Opt. Soc. Amer., 58: 855-6(June 1968).

Contributions of individual shells to the values of the magnetic spin-orbit integrals ζ_{5f} and ζ_{6d} are tabulated. Values of the magnetic interaction integrals used to compute these contributions are listed in another table. (A.G.W.)

29227 INTRA-ATOMIC MAGNETIC INTERACTIONS FOR f ELECTRONS. Judd, B. R.; Crosswhite, H. M.; Crosswhite, Hannah (Johns Hopkins Univ., Baltimore). Phys. Rev., 169: 130-8(May 5, 1968).

An examination is made of the effects of spin–spin and spin–other-orbit interactions on the energy levels of f-electron configurations. The theory is applied to several rare-earth atoms and ions under a number of simplifying assumptions. Considerable improvements in the fits between experiment and theory are obtained, particularly for the sextets of Gd IV. Electrostatically correlated spin–orbit interaction is studied and found not to be susceptible to parametric absorption into the ordinary spin–orbit and spin–other-orbit interactions. The various contributions to the effective Hamiltonian for two electrons are decomposed into parts having well-defined group-theoretical properties, in preparation for their calculation for any configuration f^N. (auth)

29228 EFFECT OF PARAMAGNETIC IMPURITY ON THE LONG LIFETIME OF POSITRONS. II. OXYGEN MOLECULE AS IMPURITY. Majumdar, Chanchal K. (Tata Inst. of Fundamental Research, Bombay); Bhide, Manohar G. Phys. Rev., 169: 295-9(May 10, 1968).

The quenching cross section σ of the oxygen molecule for the long lifetime τ_2 of positron annihilation is computed: $\sigma = 3.56 \times 10^{-18}$ cm^2. This is in fair agreement with the experimental data at low oxygen concentrations. An explanation is offered for the tremendous decrease of quenching cross section for high concentrations, and the need for improved experimental data is pointed out. (auth)

29229 THEORETICAL CALCULATION OF ATOMIC SPECTRA USING DIGITAL COMPUTERS. Cowan, Robert D. (Los Alamos Scientific Lab., N. Mex.). Contract W-7405-eng-36. J. Opt. Soc. Amer., 58: 808-18(June 1968). (LA-DC-9280).

For an arbitrary electron configuration $l_1^{n_1} l_2^{n_2} l_3^{n_3} \ldots$, analytical expressions are derived for the energy-matrix coefficients of the electrostatic-interaction parameters $F^k(l_i,l_j)$ and $G^k(l_i,l_j)$ and of the spin–orbit parameters $\zeta(l_i)$. A computer program is described, which calculates decimal values of these coefficients for any configuration with less than five open subshells, starting from only a table of the terms, parents, and coefficients of fractional parentage for each open subshell $l_i^{n_i}$. Given also a set of values of the parameters, the program evaluates and diagonalizes the energy matrices to obtain the eigenvalues and eigenvectors of the states belonging to this configuration. If so specified, the program does the above for two configurations of opposite parity, differences eigenvalues to obtain wavelengths for dipole transitions, and from the eigenvectors computes line strengths and (given an absolute value for the reduced dipole matrix element) transition probabilities. (auth)

29230 $4f^{13}5d^2$ CONFIGURATION OF SINGLY IONIZED YTTERBIUM (Yb II). Spector, Nissan (Soreq Nuclear Research Center, Yavne, Israel). J. Opt. Soc. Amer., 58: 837-42(June 1968).

Sixty high odd levels of Yb II are interpreted as $4f^{13}5d^2$ levels. A least-squares fit with 10 parameters results in a rms error of 239 cm^{-1} (1.1% of the total width). Good agreement is also obtained between calculated and observed g factors. Designations in $J_I L_{II}$ coupling are given. (auth)

29231 INTERACTION OF AN ATOM WITH A MONOCHROMATIC FIELD IN THE MODEL OF STRONG INTERACTIONS. Kolchenko, A. P.; Rautian, S. G. (Inst. of Physics of Semiconductors, Novosibirsk, USSR). Zh. Eksp. Teor. Fiz., 54: 959-73(Mar. 1968). (In Russian).

The problem of the behavior of atoms in the field of a plane traveling monochromatic wave is solved in the resonance approximation, taking into account the pressure effects in the model of strong collisions. (auth)

29232 MULTIPLE IONIZATION OF THE RARE GASES BY SUCCESSIVE ELECTRON IMPACTS (0 TO 250 eV). II. 1S–2S TRANSITION IN He^{3+}. Redhead, P. A.; Feser, S. (National Research Council, Ottawa). Can. J. Phys., 46: 865-9(Apr. 1, 1968).

The tertiary collision sequence of electrons with helium ($He \rightarrow He^+ \rightarrow He^{+m}(2S) \rightarrow He^{2+}$) has been observed with a trapped-ion mass spectrometer. The variation of He^{2+} ion current with electron energy shows a threshold at 40.8 eV, and structure, which results from excitation to autoionizing states of the atom below the n = 3 threshold of He^+, is observed in the range 45 to 49 eV. Estimates of the cross section for the 1S–2S transition in He^+ lie slightly below the values from close-coupling calculations. (auth)

29233 MUONIUM AND MESONIUM WATER MOLECULES. Kim, Y. N. (Texas Technological Coll., Lubbock). Nuovo Cim., B, 55: 286-7(May 11, 1968).

It is pointed out that due to the mean lifetimes of K^+ and π^+, it is possible for these particles to form waterlike molecules. (M.O.W.)

29234 ON RADIO-FREQUENCY TRANSITIONS AND NUCLEAR AND ELECTRON POLARIZATION FOR HYDROGEN MOLECULAR IONS H_2^+. Blicharski, J. S. (Univ. of British Columbia, Vancouver). Can. J. Phys., 46: 823-7(Apr. 1, 1968).

Relative intensities of hyperfine transitions and nuclear and electron polarizations have been calculated for hydrogen molecular ions H_2^+. (auth) (Canada)

29235 RESONANCE PROCESSES IN PHOTOEFFECT. Kompaneets, A. S. (Inst. of Chemical Physics, Moscow). Zh. Eksp. Teor. Fiz., 54: 974-7(Mar. 1968). (In Russian).

It is shown that the polarizability of the atomic residue leads to the appearance of resonance areas on the curves of dependence of the coefficient of photoelectric absorption of quanta by an outer electron at the quantum energy of the order of the residue excitation energy. (auth)

29236 TAKING INTO ACCOUNT THE COULOMB INTERACTION IN MULTIPHOTON IONIZATION. Perelomov, A. M.; Popov, V. S.; Kuznetsov, V. P. (Inst. of Theoretical and Experimental Physics, Moscow). Zh. Eksp. Teor. Fiz., 54: 841-54 (Mar. 1968). (In Russian).

The Coulomb interaction between an electron and an atomic residue in the ionization of atoms by the field of a strong wave of light is taken into account in terms of quasi-classical approximation. (auth)

29237 SPIN–ORBIT COUPLING IN MANY-ELECTRON ATOMS. Thorhallsson, J.; Fisk, C.; Fraga, S. (Univ. of Alberta, Edmonton). J. Chem. Phys., 48: 2925-7(Apr. 1, 1968).

Spin–orbit splitting factors have been calculated from existing analytical Hartree–Fock functions for a number of isoelectronic series. It is found that there is an excellent agreement with the values obtained from experimental data, whenever available. (auth)

29238 QUANTUM-MECHANICAL TREATMENT OF INELASTIC COLLISIONS. I. GENERAL THEORY AND APPLICATION TO NONREACTIVE COLLISIONS. Diestler, Dennis J.; McKoy, Vincent (California Inst. of Tech., Pasadena). J. Chem. Phys., 48: 2941-50(Apr. 1, 1968).

A general method for the quantum-mechanical treatment of the inelastic collision of composite particles is presented. The method, which is applicable to both nonreactive and reactive collisions, consists of constructing the total stationary scattering wavefunction describing the collision as a linear combination of linearly independent functions which satisfy the Schroedinger equation and also arbitrary boundary conditions specified in the asymptotic region. The formalism is developed for nonreactive collisions using a collinear model to simplify the mathematical treatment. In this paper, it is applied to two examples of impulsive collisions. In one case, for which a comparison is possible, calculated transition probabilities agree well with previously published values. (auth)

29239 METHOD OF CALCULATING PHASE SHIFTS FOR SPHERICALLY SYMMETRIC POTENTIALS. Eu, B. C. (Harvard Univ., Cambridge, Mass.). J. Chem. Phys., 48: 2852-9 (Apr. 1, 1968).

A method of calculating the phase shifts for spherically symmetric nonsingular potential is presented. The radial Schroedinger equation is reduced to a Ricatti's equation which is solved in the form of a continued fraction. Illustrative calculations of S-wave phase shifts for an attractive exponential potential are made with the first and second approximants of the continued fraction in comparison with the exact and Born phase shifts. For the potential parameter chosen (Z = 2 and 2.6) the agreement with the exact value and the over-all behavior of the phase shifts as a function of the momentum is reasonably satisfactory in contrast to the Born phase shift. A brief discussion of the possible application of the method and its limitations are given along with a remark on the extension to singular potentials. The convergence of the continued fractions is discussed with an example of an exponential potential in the appendix. (auth)

29240 SPIN–ORBIT COUPLING IN SOME POSITIVE IONS OF Cr, Mn, AND Fe. Fisk, C.; Valdemoro, C.; Fraga, S. (Univ. of Alberta, Edmonton). J. Chem. Phys., 48: 2923-5(Apr. 1, 1968).

The spin–orbit splitting factors for various terms of positive ions of Cr, Mn, and Fe have been evaluated from existing analytical Hartree–Fock functions. The agreement with the experimental values, whenever available, is satisfactory. (auth)

29241 EVIDENCE FOR TRANSIENT HYPERFINE FIELDS ON FAST IONS IN FERROMAGNETIC MEDIA. Borchers, R. R. (Univ. of Wisconsin, Madison); Herskind, B.; Bronson, J. D.; Grodzins, L.; Kalish, R.; Murnick, D. E. Contract AT(30-1)-2098. Phys. Rev. Lett., 20: 424-7(Feb. 26, 1968). (MIT-2098-406).

Anomalous precessions have previously been observed in the perturbed angular correlations of γ rays following Coulomb excitation and consequent implantation of the recoil ions into polarized ferromagnetic host materials. Measurements were made in this study on even isotopes of Cd, Ru, Pd, and Mo, in addition to those reported previously on Te, Pt, Hg, and Se. In each case the first 2^+ level was Coulomb excited by ~35-MeV ^{16}O ions from the Univ. of Wisconsin tandem accelerator, and the decay γ rays were detected in coincidence with the backscattered oxygen ions. Host materials of Fe, Ni, Co, Gd, and Cu were used. Measured angular-correlation parameters were in excellent agreement with theoretical calculations. (W.D.M.)

29242 QUANTUM CORRECTIONS TO TIME CORRELATION FUNCTIONS. Hynes, James T. (Princeton Univ., N. J.); Deutch, J. M.; Wang, Chin Hsien; Oppenheim, Irwin. J. Chem. Phys., 48: 3085-91(Apr. 1, 1968).

The first quantum correction to a time correlation function is obtained by expanding the quantum-mechanical correlation function in powers of Planck's constant. Quantum corrections to time correlation functions are of interest because they may be used to obtain quantum corrections to transport properties. An application of the formalism to nuclear spin–lattice relaxation is included. A formal expression is obtained for the first quantum correction to the lattice time correlation functions. The effect of this correction on the relaxation time is indicated. The possibility of using the first quantum correction to calculate isotope effects on transport properties is discussed. (auth)

29243 AFTERGLOW STUDIES OF THE REACTIONS He^+, $He(2^3S)$, AND O^+ WITH VIBRATIONALLY EXCITED N_2. Schmeltekopf, A. L.; Ferguson, E. E.; Fehsenfeld, F. C. (Environmental Science Service Administration, Boulder, Colo.). J. Chem. Phys., 48: 2966-73(Apr. 1, 1968).

The following reactions have been measured as a function of N_2 vibrational temperature from 300°K to 6000°K: $He^+ + N_2 \rightarrow N^+ + N + He \rightarrow N_2^+ + He$, $He(2^3S) + N_2 \rightarrow N_2^+ + He + e$, and $O^+ + N_2 \rightarrow NO^+ + N$. Reactions (1) and (4) are the first ion–molecule reactions to be measured as a function of vibrational temperature of the neutral. The rate constants for Reactions (1) and (3) are found to be insensitive to the N_2 vibrational temperature. Reaction (4) increases its rate constant by about a factor of 40 with increased N_2 vibrational temperature. The branching ratio (1) to (2) increase measurably with N_2 vibrational temperature. (auth)

29244 QUANTUM-MECHANICAL TREATMENT OF INELASTIC COLLISIONS. II. EXCHANGE REACTIONS. Diestler, Dennis J.; McKoy, Vincent (California Inst. of Tech., Pasadena). J. Chem. Phys., 48: 2951-9(Apr. 1, 1968).

The theory for the quantum-mechanical treatment of inelastic collisions developed in the first paper of this series is extended to treat collinear, electronically adiabatic exchange reactions. The formalism is applied to three model potential energy surfaces for the exchange of identical particles. The calculated reaction probabilities are reasonable and two independent checks indicate that they are reliable. (auth)

29245 DETERMINATION OF THE SURFACE IONIZATION COEFFICIENT OF BARIUM ATOMS ON A TUNGSTEN SURFACE. Mittsev, M. A.; Ionov, N. I. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Tekh. Fiz., 37: 2229-33(Dec, 1967). (In Russian).

A method is discussed for measuring surface ionization coefficients that does not require accurate measurement of the current of neutral atoms incident on the ionizing surface. In the proposed method, which is discussed at some length, one simultaneously measures the separate fluxes of ions and neutral atoms leaving the adsorbing surface. The ions are immediately accelerated and enter a magnetic spectrometer; the atoms leaving the adsorber are ionized in an electron beam and subsequently enter the same spectrometer. Because the atoms do not respond to the initial accelerating field, the ions produced from them in the electron beam have lower energies when they enter the spectrometer than do the ions that left the adsorber as ions; the two fluxes are therefore separated by the spectrometer and can be separately measured. The surface ionization coefficient for barium on tungsten was measured at temperatures from about 1800 to 2600°K. When the residual gas pressure in the chamber was 3×10^{-6} mm Hg the surface ionization coefficient was maximum for a surface temperature of about 2200°K; this behavior is ascribed to adsorption of oxygen on the tungsten surface. When the residual gas pressure was 2×10^{-8} mm Hg, however, the ionization coefficient varied monotonically with the temperature in accordance with the Saha–Langmuir equation. A surface ionization work function of 4.55 ± 0.03 V was found for the tungsten surface, which is in good agreement with the thermionic work function of 4.52 ± 0.07 V found for the same surface. A value of 3.0 ± 0.5 was obtained for the coefficient A of the exponential in the Saha–Langmuir formula; this may be compared with the calculated value of A = 2.28. (ATD)

29246 ANGULAR DISTRIBUTION OF SCATTERED AND DESORBED ATOMS FROM SPECULAR SURFACES. Comsa, George (Inst. of Atomic Physics, Bucharest). J. Chem. Phys., 48: 3235-40(Apr. 1, 1968).

The angular distribution of atoms and molecules leaving a cleaved-crystal surface, on which the conditions for specular reflection are fulfilled, is analyzed. Starting from published experimental data concerning the reflecting power vs glancing-angle dependence (He–LiF system) and from some general considerations, the existence of a deviation from the cosine law of the angular distribution of atoms, leaving a specular surface after an inelastic collision, is pointed out. It is shown that this deviation is correlated with the shape of the reflecting power vs glancing-angle curve, belonging to the atoms which undergo a specular reflection on this surface. A tentative model for the specular reflection of helium on LiF cleaved-crystal surfaces is proposed; it considers, in analogy with the neutron case, the specular reflection of atoms as total reflection on a surface of positive average interaction potential. The proposed model leads to a reflecting power vs glancing-angle curve which fits rather well the experimental data. Moreover, it explains qualitatively the correlation between the shape of the reflecting power vs glancing-angle curve and the characteristics of the deviation from the cosine law of the angular distribution for atoms having undergone an inelastic collision. Experiments for the checkup of the general conclusions, as well as of the tentative model, are proposed. (auth)

29247 CALCULATION OF ANISOTROPIC EXCITATION CROSS SECTIONS AND THE POLARIZATION OF IMPACT RADIATION OF He ATOMS INDUCED BY ELECTRON AND PROTON IMPACTS. Lin, Sheng Hsien (Arizona State Univ., Tempe). J. Chem. Phys., 48: 3125-32(Apr. 1, 1968).

The excitation cross sections of helium atoms for the transitions $1s \rightarrow 2p_m$, $1s \rightarrow 3p_m$, $1s \rightarrow 3d_m$, and $1s \rightarrow 4d_m$ induced by the proton impact (5 to 40 keV) and electron impact (50 to 200 eV) have been calculated. These excitation cross sections have been used in calculating the polarization of impact radiation for the radiative transitions $^1D \rightarrow {}^1P$ and $^1P \rightarrow {}^1S$. The theoretical values of excitation cross sections and polarization of impact radiation are compared with the experimental results. (auth)

29248 HIGHLY EXCITED STATES OF MANY-ELECTRON ATOMS. Carroll, James Barr. Storrs, Conn., Univ. of Connecticut, 1967. 64p.

Thesis.

This thesis is concerned with the quantum mechanical description of auto-ionizing states of many-electron atoms. The major emphasis is on the calculational aspects of obtaining one-electron wave functions by means of a self-consistent field procedure. The decay of the auto-ionizing, or metastable, state is described within the formalism of time-dependent perturbation theory. A procedure is developed by which the iterative solutions of Schroedinger's equation (in the Hartree or Hartree–Fock scheme of approximation) are constrained such that they always converge to a bound state (normalizable) wave function. The method is similar to the Wigner R-matrix theory in that an inner solution of the equation is matched to an outer solution at some intermediate value of the radial variable. The radial wave equation is transformed to a Ricatti equation for the logarithmic derivative of the wave function. The solution to this equation is obtained as an asymptotic series, valid in the outer or tail region of the wave function. It is shown that the first two terms of this series are adequate to define the matching conditions for the inner and outer solutions of Schroedinger's equation. Calculational results are presented for several doubly excited states of argon as well as the 2s 2p state of helium. Time-dependent perturbation theory is used to describe the time development of the initial metastable state. By means of projection operators and the recognition of the role played by different time scales in the decay process, a more general result is obtained for the decay of the metastable state. (Diss. Abstr.)

29249 NEW METHOD FOR COMPUTING INELASTIC MOLECULAR SCATTERING WITH APPLICATIONS TO ATOM–DIATOM COLLISIONS. Johnson, Bernard Robert. Urbana, Ill., Univ. of Illinois, 1967. 145p.

Thesis.

A new method for computing inelastic scattering problems in the many-state coupled-channel approximation (close-coupling approximation) is developed. It is especially well suited for doing numerical calculations with a digital computer and for this purpose is superior to the usual method that involves solving a system of coupled differential equations. Three problems are discussed in detail. The first is the collinear collision of a particle with a linear harmonic oscillator. Examples of this problem are computed numerically and the results are compared to the distorted-wave results calculated with the Mott and Jackson formula. The second problem considered is that of an atom colliding with a diatomic molecule. Results of numerical calculations in both the distorted-wave and close-coupling approximation are given for the rotational excitation from the J = 0 to J = 2 and J = 1 to J = 3 rotational states of hydrogen molecules colliding with helium atoms. The interaction potentials computed by Roberts and also by Krauss and Mies are used. The third problem considered is the collision of two diatomic molecules. No numerical examples are worked for this case. (Diss. Abstr.)

29250 SCATTERING CROSS SECTIONS AND THE INTERMOLECULAR POTENTIAL FOR ARGON. Baratz, Bernard. Princeton, N. J., Princeton Univ., 1967. 141p.

Thesis.

The total collision cross section for argon atoms scattered off argon atoms was determined over a wide range of relative velocities. A study of the velocity variation of these cross sections enabled characterization of the intermolecular potential of argon. Measurements were made of the intensity reduction of one molecular beam (primary beam) when it was scattered along part of its path by another molecular beam (scattering beam). Both beams were generated using supersonic free jets. In a separate experiment, the density field of the scattering beam was measured. The latter experiment in principle enabled absolute cross sections to be calculated from the original scattering experiments. The relative velocity between the two beams was varied from 2.0 to 38.0×10^4 cm/sec, and the corresponding cross sections varied from 700 to 200 Å^2. The angular resolution of the scattering experiments

was high enough, so that in most cases more than 97% of the total cross section was measured. The low-velocity measurements were in accord with the theory of Massey and Mohr for an inverse-six potential. However, undulatory deviations from this theory as predicted by Bernstein were observed. Quantum calculations indicate that the cross sections obtained are consistent with both Kihara and Lennard-Jones models for the intermolecular potential. The parameters that best fit these models for the scattering experiments are in agreement with the same parameters determined from measurements of thermodynamic and transport properties of argon. In addition, the long-range attractive portion of the intermolecular potential is in reasonable agreement with current theoretical predictions. (Diss. Abstr.)

29251 VIBRATIONAL EXCITATION EFFECTS UPON CHARGE TRANSFER CROSS SECTION MEASUREMENTS FOR THE H_2^+ PROCESSES IN H_2, D_2, AND Ar, AND FOR D_2^+ IN H_2. Hayden, Howard Corwin Jr. Denver, Univ. of Denver, 1967. 81p.

Thesis.

Charge-transfer cross sections have been measured, and ion-beam excitation effects investigated for H_2^+ ions in H_2, D_2, and Ar gases, and for D_2^+ in H_2. The ion energy range was 250 to 1000 eV except for the H_2^+ in H_2, which was studied from 70 to 1000 eV. Electron energies in the electron-impact ion source were varied from 16.0 eV to about 21 eV. Measured cross sections for H_2^+ in H_2 and D_2^+ in H_2 increased 5 to 10% as the electron energy was decreased toward threshold, but remained constant over about the last 1 eV. Cross sections for H_2^+ in Ar at 700 eV continued to increase as the electron energy was decreased. The overall change was about 20%. This reaction showed that relative populations of excited states were changing in the electron energy range where H_2^+ in H_2 cross sections were constant. Evidently, the lower vibrational levels of H_2^+ all have about the same cross section for charge transfer in H_2. Higher states, however, have lower cross sections. Below 400 eV excited H_2^+ increased the cross section for neutralization in D_2 and above about 600 eV, they decreased the cross section.) (Diss. Abstr.)

29252 EXCITATION OF HELIUM BY FAST ELECTRONS AND POLARIZATION OF THE RESULTING RADIATION. Moussa, Hammam Rashad Moustafa. Leiden, Rijksuniversiteit te Leiden, 1967. 125p.

Thesis.

Absolute excitation cross sections for 0.05- to 6-keV electrons incident on He were determined from intensity measurements of the emitted radiation created by a transition of the excited level to a lower-lying level. The degree of polarization of the emitted radiation was also measured. The energy dependence of the excitation cross sections of the optically allowed transitions as well as the forbidden transitions was found to be in very good agreement with the Bethe approximation. In the case of triplet excitation the decrease of the experimental excitation cross sections with increase of impact energy was much smaller than predicted by the Ochkur theory. Cross sections for excitation of He by electrons agreed well with cross sections for excitation by protons of equal velocities at high velocity. (A.G.W.)

29253 NUCLEAR CORRECTIONS TO ATOMIC ENERGY LEVELS: AN EFFECTIVE POTENTIAL APPROACH. Grotch, Howard. Ithaca, N. Y., Cornell Univ., 1967. 132p.

Thesis.

The current status of the hyperfine discrepancy is discussed. It appears that the resolution of the difficulty has recently been found in terms of a change in the fine structure constant; this modification has been inferred from an ac Josephson effect experiment which obtains an improved value of the constant 2e/h. (Disser. Abstr.) (TSS)

29254 HEAVY PARTICLE COLLISIONS. Conference held at the Queen's University of Belfast, Northern Ireland, April 1-3, 1968. London, Institute of Physics and Physical Society, 1968. 300p. 33s. (CONF-680415).

The Conference covered experimental and theoretical research concerned with atomic and molecular collision processes involving charged and uncharged particles, including multiple collision processes. Electron impact processes were excluded. A separate abstract is prepared for each of the 53 papers. (UK)

For abstracts of individual papers see: 28070, 28077, 29255–29304, and 29682.

29255 EXCITATION OF HELIUM BY FAST PROTONS. Bell, K. L.; Kennedy, D. J.; Kingston, A. E. (Queen's Univ., Belfast). pp 10-14 of Heavy Particle Collisions. London, Institute of Physics and Physical Society, 1968.

From Conference on Heavy Particle Collisions, Belfast. See CONF-680415.

It was found that for proton excitation of helium theory and experiment do not agree even at large impact energies. In order to obtain some information about the accuracy of the Born approximation the experimental results were normalized to the first Born cross sections at large impact energies. Examples are given involving n'D, 3'D, 4'D, 5'D and 6'D transitions. It is indicated that the Born approximation cross section for n'D transitions is quite accurate down to 50 keV. (auth) (UK)

29256 PROTON–HYDROGEN SCATTERING. Cheshire, Ian M. (Atomic Energy Research Establishment, Harwell, Eng.). pp 15-20 of Heavy Particle Collisions. London, Institute of Physics and Physical Society, 1968.

From Conference on Heavy Particle Collisions, Belfast. See CONF-680415.

Coupled-channel calculations are performed for proton–hydrogen scattering using an expansion in atomic orbitals in which the effective charge seen by each orbital is allowed to vary with time. (auth) (UK)

29257 EXCITATION OF THE 4 1S LEVEL OF HELIUM BY HYDROGEN IMPACT. Crothers, D. S. F. (Queen's Univ., Belfast). pp 21-30 of Heavy Particle Collisions. London, Institute of Physics and Physical Society, 1968.

From Conference on Heavy Particle Collisions, Belfast. See CONF-680415.

The studies of Bates and Crothers (Proc. Phys. Soc., 90: 73-80 (1967)) on inelastic collisions between hydrogen and helium atoms at intermediate energies are discussed. Allowance was made for projectile–target electron exchange using first-order orthogonal treatment, and the Ochkur–Rudge approximation was applied to the exchange amplitudes involved. It is pointed out that the formulae obtained only hold true if the initial and final bound-state helium wave functions are orthogonal, whereas the necessarily approximate helium wave functions for 'S states are generally nonorthogonal. The recently published cross sections at intermediate energies (60 to 160 keV) for excitation of ground state helium to the 4'S level by hydrogen impact must also be taken into account (Robinson and Gilbody, Proc. Phys. Soc., 92: 589-601(1967)). (UK)

29258 REARRANGEMENT COLLISIONS FOR HIGH ENERGIES (LINEAR MODEL). Dettmann, K. (Technische Hochschule, Aachen). pp 31-41 of Heavy Particle Collisions. London, Institute of Physics and Physical Society, 1968.

From Conference on Heavy Particle Collisions, Belfast. See CONF-680415.

Three masses m, M and M' interacting by potential energies w, W and w' are considered. The asymptotic behaviour of the charge exchange cross section for arbitrary masses and a rather general class of potentials is calculated for high energies. In the initial state m is bound to M in the ground state; in the final state m is bound to M' in the ground state. For convenience attention is concentrated on a one-dimensional model in the discussion of the general formulas. (auth) (UK)

29259 REMARK ON THE PARAMETRIC TREATMENT. Fennema, J. W. R. (Fundamenteel Onderzoek der Materie, Amsterdam). pp 42-5 of Heavy Particle Collisions. London, Institute of Physics and Physical Society, 1968.

From Conference on Heavy Particle Collisions, Belfast. See CONF-680415.

The description of atomic collision processes is often made by means of the parametric (or impact-parameter) treatment. An investigation is made on the extent to which this treatment can be applied when the full (though simplified) quantum mechanical treatment is formulated with the aid of wave packets. (auth) (UK)

29260 ON THE ACCURACY OF THE SECOND BORN APPROXIMATION. Holt, A. R. (Univ. of Essex, Eng.); Moiseiwitsch, B. L. pp 46-9 of Heavy Particle Collisions. London, Institute of Physics and Physical Society, 1968.

From Conference on Heavy Particle Collisions, Belfast. See CONF-680415.

In a paper by Cheshire and Sullivan (1967) the cross sections for the 1s → 2s and 1s → 2p excitations of atomic hydrogen by proton impact were calculated, making exact allowance for the coupling to all s states (zero-order approximation) and to all s and p states (first-order approximation). These calculations enable the accuracy of the simplified second Born approximation applied to the above processes by Kingston et al. (1960) and by Holt and Moiseiwitsch (1968) to be assessed. (auth) (UK)

29261 PROTON IMPACT EXCITATION OF H(2s). McDowell, M. R. C. (Atomic Energy Research Establishment, Harwell, Eng.); Cheshire, I. P.; Catlow, G. W. pp 57-63 of

Heavy Particle Collisions. London, Institute of Physics and Physical Society, 1968.

From Conference on Heavy Particle Collisions, Belfast. See CONF-680415.

Various methods have been proposed for including continuum contributions in eigenfunction expansions for the proton–hydrogen atom problem. Calculations for the process $H^+ + H(1s) \rightarrow H^+ + H(2s)$ discussed in this paper were reported in the impulse approximation (Coleman 1967), a Sturmian expansion (Gallaher and Wilets 1967), and in an angular momentum expansion (Cheshire and Sullivan 1967), all of which include some continuum contributions. Results obtained using a closure approximation due to Cheshire (1965) are briefly reported. (auth)

29262 CALCULATIONS ON CAPTURE FROM D(1s) AND He($1s^2$) BY PROTONS. Mapleton, R. A. (Air Force Cambridge Research Lab., Bedford, Mass.). pp 64-9 of Heavy Particle Collisions. London, Institute of Physics and Physical Society, 1968.

From Conference on Heavy Particle Collisions, Belfast. See CONF-680415.

The distorted wave interaction together with the plane wave approximation were used to calculate cross sections, Q(dw), for the following processes (assuming infinite nuclear binding energies for D^+, D):

$$H^+ + D(1s) \rightarrow \begin{cases} H(1s) \\ H(2s) + D^+ \\ \Sigma H(2p_m) \end{cases}$$

and $H^+ + He(1s^2) \rightarrow H(1s) + He(1s)$, despite the possible inadequacy of the plane wave approximation. The Born prior cross sections, Q(i), were also obtained for (2). Both calculations employed the Hylleras atomic wave function, $\psi(He) = Z^3/\pi \exp[-Z(r_1 + r_2)]$, Z = 1.6875. The range of impact energies, E, extended to 100 MeV for all cross sections. Studies were also made of Feynman integrals. The Q(dw) values for (1) confirmed that such cross sections are nearly independent of the nuclear mass of the target at high impact velocities, provided that the other atomic parameters are the same. Capture processes represented by $H^+ + A(L_i) \rightarrow H(ns) + A^+(L_f)$ are also considered. Results are discussed and compared with those of other authors. (UK)

29263 BORN ESTIMATES FOR CAPTURE FROM N, O, AND Ar BY PROTONS. Mapleton, R. A. (Air Force Cambridge Research Lab., Bedford, Mass.). pp 70-4 of Heavy Particle Collisions. London, Institute of Physics and Physical Society, 1968.

From Conference on Heavy Particle Collisions, Belfast. See CONF-680415.

The OBK cross sections were calculated for

$$H^+ + Ar(^1S) \rightarrow H(1s) + \begin{cases} Ar^+ (^2P;\ np^5) \\ Ar^+ (^2S;\ ms) \end{cases},$$

where n = 2, 3, and m = 1, 2, 3, the residual Ar ions being left in their respective ground state configurations. The one-electron orbitals calculated by Bagus (1965) were used in this calculation. Estimates of the Born prior values for capture from N, O, and Ar into H(1s) were obtained from the formula Q(est.) = R(H; E) Σ Q(OBK; E; A) where R(H; E) = [Q(prior; E; H)/Q(OBK; E; H)]. Accomodations for capture into all H(ns) states were estimated using Oppenheimer's n^{-3} rule. Predictions are compared with experimentally determined cross sections. Results suggest that total cross sections for capture from N_2 and N are nearly equal, for the range of impact energies investigated. Estimated total cross sections were in fair accord with the values predicted by classical calculations, and in some cases with measured values. (UK)

29264 IONIZATION BY PROTON IMPACT OF NEUTRAL ATOMS WITH OUTER 2P AND 3P ELECTRONS. Poach, G. (University Coll., London). pp 75-7 of Heavy Particle Collisions. London, Institute of Physics and Physical Society, 1968.

From Conference on Heavy Particle Collisions, Belfast. See CONF-680415.

The Born approximation was used to calculate collision cross sections for processes of the type $A + H^+ \rightarrow A^+ + e + H^+$, where A represents an atom in its ground state and A^+ the corresponding residual ion in its ground configuration. The atoms considered were all the neutral systems boron to neon and aluminum to argon. In cases where there is more than one spectral term associated with the ground configuration of the residual ion, cross sections for each possible transition were evaluated separately. Only the possibility of detachment of one of the outer electrons has so far been considered. Inner shell processes may give significant contributions at the higher energies, and will be investigated. Only in the cases of neon and argon is there any experimental data for ionization and a comparison with the present results shows that in both cases the calculated cross sections are larger than the experimental values by a factor of 1.5 to 2 in the asymptotic region. This may be attributed to the fact that contributions to the cross section from low values of the angular momentum of the ejected electron are important and that for these partial waves these are significant departures from the Coulomb field which were not taken into account. (auth)

29265 IONIZATION OF NEON ATOMS BY NEON IONS. Wheeler, G. A. (Central Electricity Generating Board, Bristol, Eng.). pp 78-80 of Heavy Particle Collisions. London, Institute of Physics and Physical Society, 1968.

From Conference on Heavy Particle Collisions, Belfast. See CONF-680415.

Few calculations have been carried out on ionization processes that occur in a collision between two complex atoms. In the present studies Born's approximation is used to determine the cross section for $Ne^+ + Ne(^1S) \rightarrow Ne^+ + Ne^+ (^2P) + e$ for the first three partial waves of the ejected electron. Although multiple ionization and double transitions will occur at high energies, no account is taken of these processes in this work. (auth) (UK)

29266 ION–ION NEUTRALIZATION RATE MEASUREMENTS BY THE SUPERIMPOSED BEAM TECHNIQUE. Aberth, William; Peterson, James R.; Lorents, Donald C.; Hesterman, Victor W.; Cook, Charles J. (Stanford Research Inst., Menlo Park, Calif.). pp 82-4 of Heavy Particle Collisions. London, Institute of Physics and Physical Society, 1968.

From Conference on Heavy Particle Collisions, Belfast. See CONF-680415.

Positive ion–negative ion neutralization rates are being measured for various atomic and molecular ion species of interest in atmospheric physics. These include $O^+ + O^-$, $N^+ + O^-$, $NO^+ + O_2^-$, $O_2^+ + O_2^-$, and $N_2^+ + O_2^-$. The energy range of the measurement is 0.1 to 100 eV, and the resolution is about 0.1 eV. The experimental technique is described involving merging the positive ion and negative ion beams by means of a magnetic field. (auth) (UK)

29267 FRAGMENTATION OF MOLECULAR GASES BY 5 TO 45 keV PROTONS. Browning, R.; Gilbody, H. B. (Queen's Univ., Belfast). pp 85-90 of Heavy Particle Collisions. London, Institute of Physics and Physical Society, 1968.

From Conference on Heavy Particle Collisions, Belfast. See CONF-680415.

Collisions involving ionization and fragmentation by 5- to 45-keV protons during passage through thin targets of H_2, N_2, CO and CH_4 were investigated by mass spectrometric analysis of the slow ionic products of single collisions. Particular care was taken to ensure that all these ions were collected and recorded with high efficiency, in spite of the often wide spread in both their energies of formation and initial direction. (auth)

29268 ELECTRON LOSS IN COLLISIONS INVOLVING FAST METASTABLE HELIUM ATOMS. Gilbody, H. B.; Browning, R.; Levy, G. (Queen's Univ., Belfast). pp 93-8 of Heavy Particle Collisions. London, Institute of Physics and Physical Society, 1968.

From Conference on Heavy Particle Collisions, Belfast. See CONF-680415.

Previous experimental work by the authors on charge-changing collisions during the passage of 60 to 400 keV helium beams through hydrogen and helium is discussed. Cross sections for one-electron loss were determined from direct measurements of electron stripping when the helium beam was passed through a thin gaseous target. These cross sections were found to be strongly dependent on the pressure of the neutraliser gas. The measurements also showed that the cross sections obtained using thick neutralisers were strongly dependent on the gas used. Results indicated that even with a thick neutraliser there may still be a significant fraction of metastable atoms present, and this fraction may be appreciably different for different neutraliser gases. For a complete interpretation of data of this type a quantitative assessment is required of the fast metastable atom population produced during transit of the beam through the neutraliser cell. In the work described, by studying the attenuation of a beam of fast helium atoms by electron loss collisions during passage through hydrogen, both the metastable atom population and the electron loss cross sections of the ground state and metastable components of the beam were determined. It was assumed that, at the impact energies concerned, collisions involving two-electron loss or one-electron capture were relatively unlikely, and that most of the metastable atoms were destroyed by collisions involving electron loss rather than de-excitation. The results indicate the need to take into account the possible presence of metastable atoms in fast helium beams by charge transfer. The strong influence of even a small metastable

atom component also indicates that a satisfactory description of the charge equilibrium of fast helium beams during passage through thick gaseous targets cannot always be given in terms of a simple three-component system. (UK)

29269 DIFFERENTIAL SCATTERING WITH CAPTURE FOR PSEUDO-CROSSING SYSTEMS. Hasted, J. B.; Alam, G. D. (University Coll., London). pp 99-101 of Heavy Particle Collisions. London, Institute of Physics and Physical Society, 1968.

From Conference on Heavy Particle Collisions, Belfast. See CONF-680415.

Measurements of differential scattering with single electron capture were made for the pairs O^{2+} + Ne and O^{2+} + He, in which the p electron starts and finishes in an S-configuration atomic system. The polar scattering angular resolution was better than 15′ in the apparatus used. The probability of capture P is related to the scattered ion fluxes by $P = I^{+}/(I^{+} + I^{2+})$ and is shown plotted against the impact parameter ρ calculated using a solution of the classical scattering equation for combined polarization and dispersion interaction of X^{2+} Y. The calculated nuclear separations R_x of pseudo crossings are indicated. The ion beam can contain a proportion of O^{2+} ^1D, ^1S excited states; this complicates the characteristic equal magnitude oscillations in $P(\rho)$ which are characteristic of those calculated for pseudo-crossing collisions. There is possibly a super-position of sets of equal magnitude oscillations, each persisting as far as its characteristic R_x. The apparent inconsistencies when the calculated maximum impact parameters for transition are compared with R_x may indicate inadequacy in the classical analysis. It is apparent that the oscillations in these pseudo-crossing collisions $P(\rho)$ are of smaller amplitude than those in the noncrossing Ne^{+} + Ar capture collision. The angular resolution was inadequate to show the full amplitude of the oscillations, and deconvolution is precluded by the extremely rapid variation in I^{+}, $I^{2+}(\theta)$. The smaller amplitudes of the pseudo-crossing oscillations may arise from interference with other levels, but more probably from closer spacing of oscillations. (auth) (UK)

29270 Z-DEPENDENCE OF ATOMIC STOPPING. Dearnaley, G.; Poate, J. M.; Wilkins, M. A. (Atomic Energy Research Establishment, Harwell, Eng.). pp 91-2 of Heavy Particle Collisions. London, Institute of Physics and Physical Society, 1968.

From Conference on Heavy Particle Collisions, Belfast. See CONF-680415.

The discovery of channeling of energetic ions in crystal lattices has yielded a useful tool for the study of the stopping process itself, and two recent channelling studies showed a very strong Z_1 dependence of the electronic stopping cross section (Eriksson, Phys. Rev. 161: 219(1967); Eisen (to be published in Can. J. Phys. (1968)). Both channeling measurements were carried out at ion velocities of 1.5×10^8 cm/sec, where the stopping is almost completely electronic. In these measurements we thus have the almost idealized situation of collisions with a single impact parameter and the energy losses due to electronic processes. The results should therefore present an excellent check on any relevant energy loss theory. Two similar statistical theories (Russek and Thomas (1958) and Firsov (1959)) of energy loss due to the ionization produced by high energy atomic collisions would appear to be promising. Both invoke a semi-classical model in which the electron clouds sweep through each other, transferring energy by a friction-like mechanism. The Firsov approach gives an analytic and successful value for the average energy loss, but appears somewhat intractable to incorporation of any electronic shell structure dependence; the Russek model would appear more attractive in this respect. Studies are in progress to relate these approaches to the specific problem of the strong Z_1 dependence of the energy loss of perfectly channeled ions, and further experimental measurements of the energy loss of ^{24}Na, ^{32}P, and other ions channeled in Si are being made using a tracer technique. (auth) (UK)

29271 LOW ENERGY HEAVY IONS IN RADIOBIOLOGICAL PHYSICS. Hughes, S.; Watt, D. E. (United Kingdom Atomic Energy Authority, Chapelcross, Scotland). pp 102-9 of Heavy Particle Collisions. London, Institute of Physics and Physical Society, 1968.

From Conference on Heavy Particle Collisions, Belfast. See CONF-680415.

Some experimental work is described on the biological effects of heavy ions, such as those of hydrogen, carbon, oxygen, and nitrogen, which occur as recoil particles in neutron irradiation of biological materials. Attention is confined to the energy range 5 to 100 keV. Relative biological effectiveness (RBE) and linear energy transfer (LET) are discussed. Low energy heavy ions are of particular interest because of the decrease in predominance of ionization relative to elastic scatter, charge exchange, and dissociation processes, any of which may be at least as significant as ionization in producing biological effects. Measurements were made of some of the parameters defining ion behavior in organic materials, for example, range-energy relationships and total apparent ionization cross sections. There is some evidence to suggest that the C−H bond may play a significant role in biological damage. For this reason gaseous alkanes, alkenes and alkynes were investigated. The experimental set up is described in detail. Results are tabulated for the range of H^{+} ions in Ar, CO_2, N_2, CH_4, C_2H_2, C_2H_4, C_3H_8 and C_4H_{10}, and for N^{+} in CH_4. (UK)

29272 MODEL OF TRACKS OF HEAVY PARTICLES IN WATER. Mozumder, A.; Chatterjee, A.; Magee, J. L. (Univ. of Notre Dame, Ind.). pp 110-15 of Heavy Particle Collisions. London, Institute of Physics and Physical Society, 1968.

From Conference on Heavy Particle Collisions, Belfast. See CONF-680415.

Spatial inhomogeneity of energy deposition in matter by high energy particles has a particular significance for their chemical action. Strictly speaking there can be no general track model (pattern of deposited energy) because the ultimate chemical effects depend significantly upon the specific system involved, the set of chemical reactions which occur, etc. The initial stages, however, are physical rather then chemical in nature and they play the major part in establishing the size and shape of the regions in which the primary reactive intermediates are formed, more or less independently of the specific system involved. Calculations are described which have as their objective application to chemical measurements on aqueous solutions. (auth) (UK)

29273 EXPERIMENTAL STUDIES OF COLLISIONAL DETACHMENT FOR NEGATIVE OXYGEN IONS. Roche, A. E.; Goodyear, C. C. (Univ. of Liverpool). pp 116-20 of Heavy Particle Collisions. London, Institute of Physics and Physical Society, 1968.

From Conference on Heavy Particle Collisions, Belfast. See CONF-680415.

In view of the interest in low-energy collisional detachment of electrons from negative oxygen ions as a contributory process in ionization current growth, upper atmosphere research and other fields, direct experimental measurements of the absolute cross sections are desirable. Such investigations would also contribute towards a better understanding of the general theory of heavy-particle collisions. The reactions $O^{-} + O_2 \rightarrow O + O_2 + e$ and $O_2^{-} + O_2 \rightarrow O_2 + O_2 + e$ have previously been investigated using beam techniques in the energy range <5 to 200 eV. The present paper describes further investigations in the low-energy region. (auth)

29274 VIBRATIONAL EXCITATION OF H_2 MOLECULES IN CENTRAL COLLISIONS WITH Li^{+} IONS. Schoettler, J.; Toennies, J. P. (Univ., Bonn). pp 121-5 of Heavy Particle Collisions. London, Institute of Physics and Physical Society, 1968.

From Conference on Heavy Particle Collisions, Belfast. See CONF-680415.

It is stated that the direct observation of vibrational excitation in molecular beam scattering experiments appears to be very difficult, especially for light molecules such as H_2, O_2, and N_2, which on the other hand are most easily accessible to theoretical treatment. For this reason, in the experimental work described, an ion beam was used, since it could be easily accelerated to energies >3 to 5 eV. The object was to look for vibrational excitation in single collisions. The inelastic collisions were identified by the velocity change of the ion beam accompanying vibrational excitation. The simple system $Li^{+} + H_2$ was chosen since the ion beam was easily formed by surface ionization and because of the large velocity change associated with the widely spaced vibrational levels ($\Delta E = 0.53$ eV). Also, for this system, no competing inelastic or reactive processes are possible at relative energies <4.5 eV. The suppression of rotational transitions was achieved by studying only central collisions with small 1^{+}. Velocities were measured by a time-of-flight technique, and the apparatus employed is described in detail. The retardation between the main peak containing undeflected ions and those scattered through small angles, and the delayed peak, was a measure of the extent of vibration excitation. For H_2 the measured retardations for energies >10 eV were significantly smaller than expected for elastic scattering. It was also possible to observe a shift from predominantly inelastic large-angle scattering to elastic scattering at laboratory angles of 7° at 10-eV laboratory energy. Thus, vibrational excitation appears to occur only in near central collisions, depending on the energy available along the line of centers. (UK)

29275 LONG-LIVED EXCITED STATES IN IONS. Turner, B. R.; Mathis, R. F.; Rugherford, J. A. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). pp 126-30 of Heavy Particle Collisions. London, Institute of Physics and Physical Society, 1968.

From Conference on Heavy Particle Collisions, Belfast. See CONF-680415.

In the study of collisions of ions and neutral species it has been shown that when the ions are formed by electron bombardment the collision cross sections often depend very strongly upon the energy of the ionizing electrons. This, in turn, indicates a strong dependence of the cross section upon the state of excitation of the ions. This may be associated with a change in the energetics of the reaction; for instance, reactions that are endothermic with ground-state ions may become exothermic or even resonant when the ions are in excited states. There is also a change to be expected in the chemistry of excited ions for different outer electron configurations, while vibrational and rotational excitation affect the Franck–Condon factors involved. Thus in experiments involving ion–neutral reactions it is often useful to know the relative abundance of excited ions and ground-state ions. In the experimental work described ions were formed by electron bombardment using several different electron energies, removed from the source, and mass analyzed. About 20 μsec elapsed from the time the ions were formed until they entered a reaction chamber. Thus only metastable states were involved in the measurements. Using the technique described, excited states in beams of O^+, O_2^+, NO^+, N^+, N_2^+, and Xe^+ were investigated. The method for determining the abundance of ions in excited states in a beam was based on the alteration of the ion beam during passage through a chamber of length l containing a gas at a number density n. The experimental procedure is described, and results are summarized. (auth)

29276 INELASTIC COLLISIONS OF SLOW ATOMS. Allison, D. C. S.; Burke, P. G. (Queen's Univ., Belfast). pp 132-7 of Heavy Particle Collisions. London, Institute of Physics and Physical Society, 1968.

From Conference on Heavy Particle Collisions, Belfast. See CONF-680415.

The theory which will allow calculation of the transitions induced between the fine-structure levels in atom–atom collisions is developed. Previous work has assumed one of the atoms to be in an S state. In the present studies allowance is made for the situation where both atoms are nonsymmetric and where, therefore, the scattering is dominated by the first-order terms in the interaction potential. An important example included in the analysis is $O(^3P)$ scattering by $O(^3P)$. (auth) (UK)

29277 SEMICLASSICAL SOLUTION TO THE EQUATIONS OF THE DISTORTION APPROXIMATION FOR ATOMIC COLLISIONS. Bates, D. R.; Crothers, D. S. F. (Queen's Univ., Belfast). pp 138-42 of Heavy Particle Collisions. London, Institute of Physics and Physical Society, 1968.

From Conference on Heavy Particle Collisions, Belfast. See CONF-680415.

The radial equations for the distortion approximation for treating inelastic encounters between atomic systems are given, and are solved analytically. Methods of obtaining the semi-classical approximation are then indicated. Computer programs have been written which will enable derived cross sections to be compared in the low energy region. (UK)

29278 THREE BODY IONIC RECOMBINATION. Bates, D. R. (Queen's Univ., Belfast); Flannery, M. R. pp 143-5 of Heavy Particle Collisions. London, Institute of Physics and Physical Society, 1968.

From Conference on Heavy Particle Collisions, Belfast. See CONF-680415.

A theory is developed which gives the rate of the three body ionic recombination process $X^+ + Y^- + Z \rightarrow [XY] + Z$ as a function of the gas density. There are two main parts to the theory. In the first part, a quasi-equilibrium statistical theory is used to determine the low-density limit to the recombination coefficient, the interaction between the third body and an ion being taken to be of the Langevin form. The second part is concerned with calculating the recombination coefficient at moderate and high gas densities. (auth) (UK)

29279 VIBRATIONAL RELAXATION OF ANHARMONIC OSCILLATOR MOLECULES. Bray, K. N. C. (Univ. of Southampton, Eng.). pp 146-56 of Heavy Particle Collisions. London, Institute of Physics and Physical Society, 1968.

From Conference on Heavy Particle Collisions, Belfast. See CONF-680415.

It is stated that recent experimental work on the vibrational de-excitation of diatomic gases has indicated relaxation rates faster than could be expected from excitation experiments at similar temperatures, sometimes by orders of magnitude. The derivation of the Landau–Teller equation for vibrational relaxation is discussed; a number of simplifying assumptions are required, leading to factors which might be considered as possible explanations of anomalously fast de-excitation rates. A possible mechanism which may provide at least a partial explanation of the experimental observations involves the combined effects of anharmonicity and rapid vibration–vibration exchanges. This paper describes calculations which model these effects, with a view to assessing their influence on vibrational relaxation. Typical results are shown as computed for nitrogen under isothermal conditions. The calculations showed that the proposed mechanism leads to a large increase in the rate of vibrational de-excitation, under extreme conditions. (UK)

29280 MULTICHANNEL REARRANGEMENT COLLISIONS BETWEEN H AND H^- AT LOW ENERGIES. Chen, Joseph C. Y.; Peacher, Jerry L. (Univ. of California, San Diego, La Jolla). pp 157-62 of Heavy Particle Collisions. London, Institute of Physics and Physical Society, 1968.

From Conference on Heavy Particle Collisions, Belfast. See CONF-680415.

In the collision system (H, H^-) with H and H^- in their ground states, a number of reaction paths are energetically possible, for example,

$$\begin{aligned} H + H^- &\rightarrow H + H^- \quad \text{(Scattering)} \\ &\rightarrow H^- + H \quad \text{(Electron Transfer)} \\ &\rightarrow H_2 + e \quad \text{(Associative Detachment)} \\ &\rightarrow H + H + e \quad \text{(Collisional Detachment)} \end{aligned}$$

Each of these reaction paths may be represented by a set of open channels. It has been shown that for each set of open channels a channel projector, p_j, which projects only on to the j'th set of open channels, may be constructed. The Schrödinger equation of the (H, H^-) reaction system may be transformed, by using the channel projectors, into a set of coupled equations for the rearrangement collisions. It was found that both the associative–detachment and the collisional–detachment channels are strongly coupled with the scattering and electron-transfer channels. This means the solving of four sets of coupled equations; means of solving are discussed. A calculation of the associative–detachment cross section was carried out. Indications were obtained that associative detachment provides a possible mechanism for generating an inverted population of the residual H_2 molecules. Oscillatory behavior of the cross section corresponding to the oscillation of the vibrational wave functions was observed. Graphs are given showing, cross sections for the production of H_2 in four sets of rotational and vibrational states in associative detachment, and for electron detachment in atomic collisions between H and H^- in their ground states. (UK)

29281 CLOSE COUPLING CALCULATIONS OF INELEASTIC CROSS SECTIONS FOR ROTATIONAL EXCITATION. Erlewein, W.; von Seggern, M.; Toennies, J. P. (Univ., Bonn). pp 163-8 of Heavy Particle Collisions. London, Institute of Physics and Physical Society, 1968.

From Conference on Heavy Particle Collisions, Belfast. See CONF-680415.

The aim of the investigation described was a study of the connection between the potential parameters for the atom–molecule interaction and integral and differential inelastic cross sections which can be measured in molecular-beam scattering experiments. As a model system He + N_2 was chosen, instead of He + H_2 which has been studied extensively in the past. The He + N_2 system has the advantage of having a potential well with a capacity for several bound states which characterizes the interactions for most molecules. At the same time the reduced mass is small enough for a partial-wave analysis at least at low relative velocities. The calculated inelastic cross sections for the j = 0 to j = 2 transition show several resonance maxima, which are discussed. (auth) (UK)

29282 METHOD FOR DETERMINING INTERACTION POTENTIALS FROM DIFFERENTIAL SCATTERING CROSS SECTIONS. Kennedy, M.; Smith, Francis J. (Queen's Univ., Belfast). pp 169-72 of Heavy Particle Collisions. London, Institute of Physics and Physical Society, 1968.

From Conference on Heavy Particle Collisions, Belfast. See CONF-680415.

Elastic differential cross sections for $^4He^+$ ions colliding with ^4He atoms as measured by Lorents and Aberth are illustrated and discussed. Two sets of oscillations are superimposed; one (with the long wave length) is due to gerade–ungerade interference; the other is due to nuclear symmetry interference. A simple theory is presented which uses the wave lengths of these oscillations and their positions to determine accurate gerade and ungerade interaction potentials for He^+ + He at short internuclear distances. (auth) (UK)

29283 ROTATIONAL SUB-EXCITATION RESONANCES IN SLOW MOLECULAR COLLISIONS. Levine, R. D.; Johnson, B. R.; Muckerman, J. T.; Bernstein, R. B. (Univ. of Wisconsin, Madison). pp 173-6 of Heavy Particle Collisions. London, Institute of Physics and Physical Society, 1968.

From Conference on Heavy Particle Collisions, Belfast. See CONF-680415.

Exact numerical results for a model problem involving the collision of a structureless atom with a rigid rotor at subthreshold energies are reported, exhibiting the main features to be expected in a real atom—molecule system (He + H_2). These results serve as a reference against which various approximate theoretical predictions of the resonance energies and phase shifts are compared. (auth) (UK)

29284 COLLISIONAL MIXING IN ALKALI ^2P STATE. Mandelberg, Hirsch I. (University Coll., London). pp 177-83 of Heavy Particle Collisions. London, Institute of Physics and Physical Society, 1968.

From Conference on Heavy Particle Collisions, Belfast. See CONF-680415.

The problem of inelastic collisions between alkali and rare gas atoms has been the subject of much study, both experimental and theoretical. This paper is concerned with the calculation of cross sections for transitions between the (J, M_J) components of the resonance ^2P multiplet of the alkali metals Na, K, Rb, and Cs, for which experimental data exist. The method used is that proposed by Callaway and Bauer (Phys. Rev. 140A: 1072(1965)) for general inelastic collisions. This is an impact parameter method of treatment, assuming a straight-line, constant velocity path of the perturbing rare gas atom, and a Van der Waals interaction potential between the atoms. (auth) (UK)

29285 UNIFORM SEMICLASSICAL APPROXIMATION FOR THE ELASTIC SCATTERING AMPLITUDE. Miller, William H. (Univ., Freiburg i. B.). pp 184-7 of Heavy Particle Collisions. London, Institute of Physics and Physical Society, 1968.

From Conference on Heavy Particle Collisions, Belfast. See CONF-680415.

For elastic scattering by a spherically symmetric potential the scattering amplitude is given by the formula

$$f(\theta) = \frac{1}{2ik}\sum_{l=0}^{\infty}(2l+1)\,e^{2i\eta_l}\,P_l(\cos\theta),\quad \theta \neq 0$$

Ford and Wheeler (Ann. Phys., 7: 259(1959)) evaluated this expression with certain semiclassical approximations and found the amplitude to be (for the usual case that the potential consists of an attractive well plus a repulsive wall) the sum of three terms—one for each impact parameter (or value of l) that corresponds to classical scattering at the angle θ. This result, however, is not valid at very small angles or if two of the classical impact parameters are close together—and the resulting "glory" and "rainbow" effects must be treated separately. In this note it is shown how the amplitude can be evaluated within a semiclassical approximation which includes the "glory" and "rainbow" effects uniformly. (auth) (UK)

29286 INTERPRETATION OF CURVE-CROSSING OSCILLATIONS IN DIFFERENTIAL SCATTERING. Smith, Felix T. (Stanford Research Inst., Menlo Park, Calif.). pp 188-91 of Heavy Particle Collisions. London, Institute of Physics and Physical Society, 1968.

From Conference on Heavy Particle Collisions, Belfast. See CONF-680415.

A prominent feature of differential atomic scattering patterns, both elastic and inelastic, is a set of strong and regular oscillations. Characteristically, these oscillations have a rather abrupt inception at a fairly constant value of the reduced scattering angle $\tau = E\theta$, which indicates a dependence primarily on the impact parameter b or the classical distance of closest approach r_0. Such behavior is consistent with the hypothesis that the feature is connected with a curve crossing between two states of different molecular orbital configurations. In elastic scattering it has been possible in some cases to deduce the location of the crossing point r_x from the value τ_x of the reduced scattering angle at the threshold of the perturbation. A second characteristic of these oscillations is the regularity of their spacing in angle and the fact that this spacing varies inversely with velocity. This behavior is also consistent with the curve-crossing hypothesis. In both elastic and inelastic scattering the curve-crossing mechanism leads to the existence of two classical trajectories in regions of r less than r_x, with their classical turning points determined by one or the other of the potentials $V_1(r)$, $V_2(r)$. An interference pattern results. The quantal problem for a two-trajectory situation reduces in the semiclassical limit to an interference between two scattering amplitudes, and a useful way of expressing the experimental spacing of the peaks is derived. A semiclassical analysis suffices to reveal many features of the full solution of the inelastic collision problem, and leads directly to an approximate functional form for the relationships. Such an analysis was made, and features of the results are enumerated. It is suggested that a simple 2-state crossing theory may be inadequate for the cases examined. (UK)

29287 REACTIONS OF EXCITED RARE GAS ATOMS WITH HD. Hotop, H.; Niehaus, A. (Univ., Freiburg i. B.). pp 194-8 of Heavy Particle Collisions. London, Institute of Physics and Physical Society, 1968.

From Conference on Heavy Particle Collisions, Belfast. See CONF-680415.

The formation of HeH_2^+ and ArH^+ in collisions of excited He and highly excited long lived Ar atoms with hydrogen has been reported. Results of a detailed investigation of ionizing collisions of metastable rare gas atoms (X*) and highly excited rare gas atoms (X**) with H_2 and HD are reported in this paper. (auth) (UK)

29288 ANALYSIS OF IONIZATION PROFILES IN LOW PRESSURE SHOCK TUBES. Hoye, J. B.; Ward, T. V.; Hobson, R. M. (Queen's Univ., Belfast). pp 199-205 of Heavy Particle Collisions. London, Institute of Physics and Physical Society, 1968.

From Conference on Heavy Particle Collisions, Belfast. See CONF-680415.

Shock tube measurements of ionization produced by thermal energy collisions in the noble gases have shown that it proceeds in distinct stages. In Regime I, immediately behind the incident shock wave, atom—atom inelastic collisions are responsible for a relatively slow rate of ionization. In Regime II, electron—atom collisions predominate and the rate of ionization is significantly greater than in I. In Regime III, the level of ionization reaches a constant value, when electron loss mechanisms become increasingly important. Recent measurements using electrostatic probe techniques have enabled the events in Regime I to be studied in more detail than was possible using microwave techniques, and measurements of the rate constants of the two-step ionizing mechanism have been reported. Methods of calculation and analysis of ionization profiles are indicated and comparisons made with experimental determinations. (UK)

29289 CROSS SECTIONS FOR THE QUENCHING OF EXCITED METAL ATOMS. Jenkins, D. R. (Shell Research Ltd., Chester, Eng.). pp 206-13 of Heavy Particle Collisions. London, Institute of Physics and Physical Society, 1968.

From Conference on Heavy Particle Collisions, Belfast. See CONF-680415.

This paper is concerned with the determination of the rates of quenching of various metal atoms in their first resonant excited levels by hydrogen, oxygen, nitrogen, water, carbon monoxide, carbon dioxide, argon and helium. The method of determination is to measure the fluorescence of the metals in flames of known composition and temperature. The principle of the method is similar to that used by other workers on the quenching of resonance radiation from metal vapours in glass bulbs when foreign gases are admitted to the bulb. The main difference is that a homogeneous isothermal part of a flame is used instead of a glass bulb. There are two main advantages of this method: it enables a larger number of metals to be studied, and the quenching by reactive gases, such as oxygen and water, can be measured since, at flame temperatures, most metal compounds are extensively dissociated. (auth) (UK)

29290 NEGATIVE ION-MOLECULE REACTIONS IN N_2O. Moruzzi, J. L.; Dakin, J. T. (Univ. of Liverpool. Westinghouse Research Labs., Pittsburgh). pp 214-19 of Heavy Particle Collisions. London, Institute of Physics and Physical Society, 1968.

From Conference on Heavy Particle Collisions, Belfast. See CONF-680415.

Although some work has been done on the negative ions produced in N_2O at low pressures, very little is known about the reactions that occur at higher pressures. Nitrous oxide has been used as a specific electron scavenger in irradiated liquid and gaseous hydrocarbons, and thus the negative ion reactions occurring in this gas are of considerable interest. The formation and subsequent reactions of negative ions in N_2O were studied by coupling a drift tube to a quadrupole mass spectrometer. Ion currents were examined at pressures between 0.3 and 10 torr, for values of E/p ranging from 0.1 to 20 V cm^{-1} $Torr^{-1}$. (auth) (UK)

29291 THEORY OF IONIC NEUTRALIZATION RATE FOLLOWING ABSORPTION OF RADIATION IN CONDENSED PHASE. Mozumder, A.; Magee, J. L. (Univ. of Notre Dame, Ind.). pp 220-6 of Heavy Particle Collisions. London, Institute of Physics and Physical Society, 1968.

From Conference on Heavy Particle Collisions, Belfast. See CONF-680415.

A high density of ions may be created in a condensed medium by the absorption of a relatively large dose of radiation. It is known from measurements on radiation-induced conductivity in low-dielectric media that only a small fraction of these ions escape mutual neutralization. A procedure is described for cal-

culating the rate at which the majority of these ions become neutralized. This is illustrated in two cases under a quasi-stationary condition called the "relaxed state." Special difficulties in treating the transient situation that exists during and immediately following irradiation are discussed. (auth) (UK)

29292 ION–ATOM INTERCHANGE STUDIES. Ong, P. P.; Hasted, J. B. (University Coll., London). pp 227-9 of Heavy Particle Collisions. London, Institute of Physics and Physical Society, 1968.

From Conference on Heavy Particle Collisions, Belfast. See CONF-680415.

Drift-tube measurements are reported of the temperature variation of positive ion–atom interchange and molecular charge transfer process rate constants for O^+N_2, O^+O_2, O^+CO, Ar^+CO, Ar^+N_2, Ar^+O_2, and Ar^+NO. The effective range of energies is <0.1 eV to >10 eV. Comparisons are made with ESSA flowing afterglow measurements and with other data. Below 0.4 eV, calculations were made using the semi-empirical "nearest resonance" method, with adiabatic parameter $\underline{a}$ = 100 Å and other less suitable values. For comparison with drift-tube data, only the kinetic temperature was varied, but full temperature variation calculations were also made. A comparison with the ESSA vibrational temperature variation data for $O^+N_2 \rightarrow NO^+ + N$ is shown. Variation of ion source electron energy for Ar^+ production shows evidence of excited ion contribution, but in the case of O^+ the excited ^2D ions are deactivated by helium buffer gas collisions. Full temperature and kinetic temperature variation comparisons afford the most sensitive test of choice of constants $\underline{K}$ and $\underline{a}$ in the "nearest resonance" calculations, and discussions are given of the details of these. (auth) (UK)

29293 LOW ENERGY POTASSIUM IONS IN NITROGEN AND HYDROGEN. Rees, J. A.; Fleming, I. A.; Tunnicliffe, R. J. (Univ. of Liverpool, Eng.). pp 230-4 of Heavy Particle Collisions. London, Institute of Physics and Physical Society, 1968.

From Conference on Heavy Particle Collisions, Belfast. See CONF-680415.

The behavior of swarms of slow potassium ions in nitrogen and hydrogen was investigated using a Bradbury and Nielsen type of drift tube and a diffusion apparatus based on Skullerud's modification of the method introduced by Townsend. Using the drift tube, the drift velocity W of the potassium ions was determined for values of E/N (E = electric field strength in V cm^{-1} and N = gas number density) between 1×10^{-17} and 340×10^{-17} V cm^2 in nitrogen and between 1×10^{-17} and 150×10^{-17} in hydrogen. The diffusion apparatus was used to obtain values of D/μ (D = diffusion coefficient and μ = W/E) for potassium ions for values of E/N between 10×10^{-17} and 350×10^{-17} in both gases. From the experimental data approximate values of the momentum transfer cross-section, q_1, and of the viscosity cross section, q_2, were calculated. (auth)

29294 MASS SPECTROMETRIC STUDIES OF IONIZATION IN SHOCK HEATED GAS MIXTURES. Wang, Charles (California Inst. of Tech., Pasadena). pp 235 of Heavy Particle Collisions. London, Institute of Physics and Physical Society, 1968.

From Conference on Heavy Particle Collisions, Belfast. See CONF-680415.

The initial stage of thermal ionization in gas mixtures behind strong normal shock waves was studied using a mass spectrometer. The sampling process, the unique role of mass-spectrometric analysis in this field, the ionization mechanism, and the effect of impurities on the ionization relaxation time of the inert gases are discussed. A detailed analysis of ion diffusion through the end wall thermal boundary layer and an investigation of the effect of the sampling process on the reaction and reaction products are described. The experiments were conducted in argon and xenon at temperatures of 10,000 to 30,000°K and pressures from 15 to 80-mm Hg. A large number of different ions were detected in "pure" (the estimated level of naturally occurring impurities was 50 ppM) argon. H^+ and O^+ were found in much greater amounts than any of the other products. The roles of H and O were studied further by mixing a small amount of H_2 or O_2 with the argon. The activation energy and the effective cross section for ionization were obtained from the measured ionization rate. For argon, the activation energy agrees within experimental accuracy with the result of Kelly (1966). For hydrogen the activation energy is about 10 eV, and this value coincides with its first excited state. The effective cross section for hydrogen is a thousand times larger than the corresponding effective cross section for the ionization of argon. This explains why small amounts of hydrogen affect the argon ionization relaxation time. (auth)

29295 SHOCK TUBE MEASUREMENTS OF REACTION RATES FOR EXCITATION AND IONISATION OF KRYPTON BY ATOM–ATOM COLLISIONS AT THERMAL ENERGIES. Ward, T. V.; Hobson, R. M. (Queen's Univ., Belfast). pp 236-42 of Heavy Particle Collisions. London, Institute of Physics and Physical Society, 1968.

From Conference on Heavy Particle Collisions, Belfast. See CONF-680415.

Measurements in shock heated argon, employing electrostatic double probes to measure ion concentrations with time behind the shock front, are first reviewed. The krypton experiments were carried out in the initial pressure range 0.14 to 1.5 torr and temperature range 6,000 to 12,000°K. A measurement typical of the variation of ion density with time behind the shock front is shown. An Arrhenius plot of $\ln (dN^+/dt)/p_1^2$, measured from experimental profiles, against $1/kT_{2s}$, is also shown. The activation energy of the process $Kr + Kr \rightarrow Kr^* + Kr$ was estimated as 9.9 ± 0.2 eV, and results supported a two step ionizing mechanism: $Kr + Kr \rightarrow Kr^* + Kr$; $Kr^* + Kr \rightarrow Kr^+ + Kr + e$, as was indicated for argon. The variation of k^* with $1/kT_2$ is also shown. A value of 3.8 ± 0.3 was indicated for the activation energy of $Kr^* + Kr \rightarrow Kr^+ + Kr + e$. Cross section proportionality constants were also calculated. It is noted that the activation energy measured for the metastable production process is close to the lower resonance level of Kr. As the ionization potential of krypton is 14.0 eV the value of 3.8 found for ionization from the metastable level is consistent with the 9.86-eV resonance level being more dominant than the 10.51-eV level in the two step ionization mechanism. (UK)

29296 DEACTIVATION OF METASTABLE EXCITED SPECIES. Young, R. A.; St. John, G. A.; Black, G.; Slanger, T. G. (Stanford Research Inst., Menlo Park, Calif.). pp 243-8 of Heavy Particle Collisions. London, Institute of Physics and Physical Society, 1968.

From Conference on Heavy Particle Collisions, Belfast. See CONF-680415.

A survey is presented of de-excitation involving $N_2(A^3\Sigma_u^+)$, $O_2(b^1\Sigma)$, and $O(^1S)$ by many gases using the technique of weak pulsed RF excitation and optical monitoring of the transient behavior of excited states. (auth) (UK)

29297 SIX-POLE MAGNET AS A NEUTRAL BEAM POLARISER AND VELOCITY SELECTOR. Brash, H. M.; Campbell, D. M.; Farago, P. S.; Rae, A. G. A.; Siegmann, H. Chr.; Wykes, J. S. (Univ. of Edinburgh). pp 252-60 of Heavy Particle Collisions. London, Institute of Physics and Physical Society, 1968.

From Conference on Heavy Particle Collisions, Belfast. See CONF-680415.

A short account is given of some detailed investigations of the "atom optic" properties of this device, treated as a thick lens. (auth)

29298 ABSOLUTE METASTABLE ATOM DETECTION. Dunning, F. B.; Smith, A. C. H.; Stebbings, R. F. (University Coll., London). pp 266-8 of Heavy Particle Collisions. London, Institute of Physics and Physical Society, 1968.

From Conference on Heavy Particle Collisions, Belfast. See CONF-680415.

The study of reactions involving metastable atoms is frequently hindered through the lack of a satisfactory means for their detection. Most commonly this is achieved through observation of the secondary electrons they may eject from a metal surface. The secondary emission coefficients are, however, sensitive not only to the nature of the metal surface but also to its state of purity, and very little reliable data concerning the absolute magnitudes of γ are available. The purpose of the study described was to determine absolute values of γ for a variety of metastable atoms impacting on well specified and reproducible surfaces. The procedure used was a development of that first employed by Stebbings (Proc. Roy. Soc., A241: 270(1957)). (auth) (UK)

29299 DIAGNOSTIC METHOD FOR MEASURING IONIZATION RATES IN SHOCK HEATED GASES. Klingenberg, H.; Siddiqui, A. (Institut fuer Plasmaphysik, Garching, Ger.). pp 269-74 of Heavy Particle Collisions. London, Institute of Physics and Physical Society, 1968.

From Conference on Heavy Particle Collisions, Belfast. See CONF-680415.

The ionization rate in shock heated gases, i.e., the variation with time of electron densities, can be measured by using a microwave technique such as was developed by W. Makios (Rev. Sci. Instr., 38: 352-4(1967)) in the 4-mm region for other measurements. The microwave power is coupled to a Lecher system passing through the plasma. This method has the advantage of high spatial resolution. The suitability of this method at low frequencies was investigated, and its advantages and disadvantages and the results of preliminary measurements are discussed. (auth) (UK)

29300 METHOD OF MEASURING STOPPING CROSS-SECTIONS USING RECOIL IONS FROM RADIOACTIVE DECAY. Warner, A. G.; Poole, D. H.; Hancock, R.; Woolley, R. L. (Central Electricity Generating Board, Berkeley, Eng.). pp 275-8 of Heavy Particle Collisions. London, Institute of Physics and Physical Society, 1968.

From Conference on Heavy Particle Collisions, Belfast. See CONF-680415.

A radioactive recoil ion source is particularly suited to time-of-flight methods, and convenient source of such ions is the active deposit from thoron (Rn 220), deposited on the front surface of a thin foil. For every recoil ion leaving the front surface of the foil there is a corresponding alpha-particle which passes through the foil and emerges from the back surface. The alpha-particle is made to strike a suitable detector and start a timer; the recoil ion, after traveling a known flight path, also strikes a suitable detector and stops the timer. The time interval gives the velocity, and hence the energy, of the recoil ion. By interposing an absorber foil of the material where stopping cross section is to be measured in the path of the recoil ions, the stopping cross-section, i.e., the energy loss/(atoms of absorber/cm^2), may be deduced from the observed increase of the time of flight. The experimental set-up is shown schematically. Results are shown for carbon, the stopping cross section of which was determined as 33×10^{-14} eV cm^2. (UK)

29301 CHARGE TRANSFER AND VIBRATIONAL EXCITATION IN H_2–H_2^+ COLLISIONS. Bates, D. R.; Reid, R. H. G. (Queen's Univ., Belfast). pp 284-92 of Heavy Particle Collisions. London, Institute of Physics and Physical Society, 1968.

From Conference on Heavy Particle Collisions, Belfast. See CONF-680415.

The theory of these processes is first considered. Assuming that electronically integrated quantities are independent of the orientations and separations of the proton pairs it is found that the rotational state of each proton pair remains unchanged, and also that change in rotational energy accompanying electron exchange is negligible; hence, rotational degrees of freedom may be ignored. Since it is assumed that H_2 and H_2^+ are in their ground states throughout, there are only two electronic states of the combined system. Cross sections, including total exchange cross section, are derived. The vibrational energies of H_2 and H_2^+ were calculated, using parameters given by Herzberg (1950), and the vibrational overlaps were deduced from Franck–Condon factors. Consideration is given to the charge exchange interaction, and cross sections were evaluated from solution of the coupled equations. Comparisons are made with experiment. (UK)

29302 EFFECT OF APPARATUS GEOMETRY ON H^++H CHARGE EXCHANGE CROSS SECTIONS. Crothers, D.; Kennedy, M.; Smith, Francis J. (Queen's Univ., Belfast). pp 293-4 of Heavy Particle Collisions. London, Institute of Physics and Physical Society, 1968.

From Conference on Heavy Particle Collisions, Belfast. See CONF-680415.

The resonant exchange cross section for $H^+ + H$ collisions was measured by counting the total number of ions scattered outside a cone about the incident direction of an ion beam impinging on an atomic hydrogen target. It has been shown that if the angle of the cone, α, is 45° (laboratory co-ordinates) then the measured number of ions equals the total number of scattered exchange ions, this number being determined by the usual definition of the exchange cross section. If the angle of the cone, α, is smaller than 45° then the cross section obtained, is too large. Some preliminary results are shown graphically. It is apparent that, except at low energies and for very small cone angles, the discrepancy is small. The undulations in the cross sections are due to rainbow scattering. (auth) (UK)

29303 LOW ENERGY ION–MOLECULE REACTIONS IN OXYGEN. Dutton, J.; Howells, P. (University Coll. of Swansea, Wales). pp 295-9 of Heavy Particle Collisions. London, Institute of Physics and Physical Society, 1968.

From Conference on Heavy Particle Collisions, Belfast. See CONF-680415.

Using an apparatus described by Dutton et al., (Phil. Trans. Roy. Soc. 259: 339-54(1966)) simultaneous determinations were made of the drift velocity W and diffusion coefficient D of positive ions produced in a glow discharge in oxygen for $2 < E/p_0 < 100$ V cm^{-1} torr^{-1}. The results showed the existence of two ion species within this range. For $E/p_0 < 15$ V cm^{-1} torr^{-1} only species A was observed, and for $E/p_0 > 28$ V cm^{-1} torr^{-1} only species B was observed. The drift velocity results show, however, that there is an interesting intermediate region in which both ion species were observed and in which the nature of the dominant species depended critically on the experimental conditions. This situation is analogous to that observed in nitrogen by Varney (1953), and may be interpreted as showing that species A and B undergo a reversible reaction in collision with the gas molecules, so that during their flight through the drift tube the ions spend part of the time as species A and part as species B. If additional information can be obtained concerning the mean energy of the ions, the drift velocity curves can be used to obtain the binding energy of the dissociating ion. Direct information about the mean ion energy was obtained from measurements of the ratio W/D. The results are shown in the form of graphs of the Townsend energy factor ϵ (ϵ = eED/kTW) versus E/p_0, which were used to calculate the binding energy of species A. It is suggested that species A may be identified as O_4^+ and species B as O_2^+. Cross sections for collisions of O_2^+ in O_2 are also discussed. (auth)

29304 COMPARISON OF THE BINARY-ENCOUNTER THEORY WITH THE BETHE THEORY FOR IONIZATION OF THE HYDROGEN ATOM BY FAST CHARGED PARTICLES. Vriens, L.; Bonsen, T. F. M. (Univ., Utrecht). pp 300 of Heavy Particle Collisions. London, Institute of Physics and Physical Society, 1968.

From Conference on Heavy Particle Collisions, Belfast. See CONF-680415.

Differential cross sections for ionization of the hydrogen atom from the n = 1 and 2 states by fast charged particles were calculated in the binary-encounter and Bethe (first Born) theory. Comparison shows good agreement between the two theories for large momentum and energy transfer. It is shown that use of an unrealistic velocity distribution of the target electron in the binary-encounter theory can lead to very wrong results. If in the Bethe theory the Coulomb final-state wave functions are approximated by plane final-state wave functions, the same correct cross sections are obtained at and near the Bethe ridge for large momentum and energy transfer as in the Bethe and binary-encounter theories, but very poor results are obtained for small momentum and energy transfer. In the Bethe theory, the numerically calculated differential cross sections per unit energy transfer ϵ (in Rydberg units) are found to be proportional to $\epsilon^{-2} + (4/3n^2)\ \epsilon^{-3}$ for large ϵ, in agreement with the corresponding binary-encounter cross section formula. For ionization from the n = 2 states calculations were made (Bethe theory) of the proportionality factors in the asymptotic total cross section formula, and the continuum contributions to the optical oscillator strength and the polarizability. (auth) (UK)

Cosmic Radiation

Refer also to abstracts 28987, 28998, 29351, and 29622.

29305 DO LOW-ENERGY COSMIC-RAY ELECTRONS INDICATE VERY HEAVY PRIMARIES? Brunstein, Karl A. (Univ. of Denver). Nature (London), 218: 649-52(May 18, 1968).

It is considered that supernovae are the likely origin of cosmic ray nuclei. This is because beams of cosmic rays seem to contain nuclei heavier than iron in astrophysically significant quantities. (auth)

29306 LOW-ENERGY SOLAR COSMIC RAY EXPERIMENT FOR OGO-F. Wolpert, M. H.; Satterblom, P. R.; Burtis, D. W.; Masley, A. J. (Douglas Aircraft Co., Santa Monica, Calif.). Contract NAS 5-9324. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: 238-41(Feb. 1968).

From 14th Nuclear Science Symposium, Los Angeles. See CONF-671026.

The Douglas OGO-F Low-Energy Solar Cosmic-Ray Experiment measures the differential energy spectrum of protons (5 to 80 MeV) and alphas (18 to 160 MeV) using two double-diffused, totally depleted silicon diodes. The pulse amplitude discrimination system, the data multiplexing scheme, and the in-flight calibrator are discussed. (auth)

29307 ADDENDUM AND ERRATUM TO "COSMIC-RAY PROPAGATION. I." Jokipii, J. R. (Univ. of Chicago). Astrophys. J., 152: 671-2(May 1968).

The purpose of this note is to point out a missprint in a previous paper (Astrophys. J., 146: 480) and to present an alternative derivation of the diffusion tensor for fast charged particles in a time-independent random magnetic field. (W.D.M.)

29308 HIGH ENERGY ELECTRONS AND EMISSION OF THE OMNIDIRECTIONAL SYNCHROTRON RADIATION IN RADIO-FREQUENCY AND X-RAY REGIONS. Verma, Satya Dev (Univ. of Chicago). Astrophys. J., 152: 537-44(May 1968).

The recent measurements of the flux and differential energy spectrum of primary electrons in the 0.2 to 300-BeV energy region made near the recent solar-minimum period (1966) are summarized. These measurements are consistent with a charge in the exponent of the power-law spectrum of primary electrons from 1.6 ± 0.15 to 2.6 ± 0.15 at about 2 to 5 BeV. It is pointed out

that the observations of the omnidirectional intensity and the spectrum of the non-thermal radio-frequency background radiation above 200 MHz are consistent with this steepening of the electron energy spectrum. Futhermore, radio observations in the 10 to 100-MHz region are in agreement with the lower-energy electron spectrum corresponding to these radio frequencies (0.2 to 2 BeV) within 50%. This indicates that the residual solar modulation of electrons in the 0.2 to 2-BeV energy region is not large. If it is assumed that the electron energy spectrum extends in the form of a power law up to $\sim 10^9$ to 10^8 BeV with the exponent 2.6, 2.8, or 3.0, then the synchrotron emission of these ultrahigh energy electrons would contribute to the recently observed diffuse component of cosmic x rays, although it does not completely account for the large flux. This assumed electron spectrum would also give a possible explanation for the observation of a small number of air showers which may have been produced by the electron or photon component of the primary cosmic rays. (auth)

29309 COSMIC RAY SOLAR DAILY VARIATION. Elliot, Harry (Imperial Coll., of Science and Tech., London). Rend. Semin. Mat. Fis. Milano, 37: 161-82(1967).

Measurements of the cosmic ray solar daily variation at a depth of 60 meters water equivalent show that the average anisotropy of primary cosmic rays in the energy range 10^{11} to 10^{12} eV can be understood in terms of a drift motion round the sun in accordance with the theoretical work of Dessler, Ahluwalia, Parker and Axford, provided one also includes a flux gradient perpendicular to the ecliptic plane. During the recent sunspot minimum of 1964/65 the drift motion vanished for primaries with energy $>10^{11}$ eV, probably because of the increased disorder of the interplanetary magnetic field at that time. During the sunspot minimum period, the remaining observable anisotropy is ascribed to the aberration effect due to the orbital motion of the earth together with that resulting from the flux gradient. (auth)

29310 INTENSITY DISTRIBUTION OF THE NUCLEAR-ACTIVE COMPONENT OF COSMIC RAYS IN METEORITES. Lavrukhina, A. K.; Ustinova, G. K. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Sov. Astron. AJ (Engl. Transl.), 11: 868-72(Mar.-Apr. 1968).

Translated from Astron. Zh., 44: 1081-6(Sept.-Oct. 1967).

Analytic formulas are derived for the distribution of nuclear-active particles in spherical, isotropically irradiated meteorites. As an illustration, the intensity of primary rays in iron meteorites of various radii is calculated, and several curves are presented for the intensity distribution of individual components of secondary radiation in a meteorite of 50-cm radius. (auth)

29311 MEASUREMENT OF THE NEUTRON FLUX ON THE KOSMOS-53 SPUTNIK. Sidneva, S. N.; Strelkov, A. S. Kosm. Issled., 6: 100-9(Jan.-Feb. 1968). (In Russian).

The neutron flux inside the sputnik was measured by means of ^{235}U fission chambers with paraffin moderators. The measurements were carried out in the magneto-calm period of January 30–31, 1965. From the data obtained, the neutron flux of the albedo and its latitudinal variation were determined in the latitudes from 0 to 60° and at heights from 300 to 800 km. The absolute albedo neutron flux was 0.16 to 0.51 neutrons/cm^2 sec with a precision of ~50%. The processes for the formation of local neutrons in the material of the sputnik and their contribution to the measured flux were examined. The average of the measured albedo neutron flux and its latitudinal variations showed satisfactory agreement with subsequent measurements on the sputnik and with theoretical calculations. (tr-auth)

29312 X RADIATION OF THE MOON AND X-RAY COSMIC BACKGROUND IN THE LUNAR SPUTNIK LUNA-12. Mandel'shtam, S. L.; Tindo, I. P.; Cheremukhin, G. S.; Sorokin, L. S.; Dmitriev, A. B. Kosm. Issled., 6: 119-27(Jan.-Feb. 1968). (In Russian).

The results of the measurement of the soft x radiation of the Moon, caused possibly by fluorescence of the lunar surface under the effect of solar x radiation are reported. The lunar x-ray flux in the range from 8 to 14 Å in different time periods is ~10 to 150 photon/cm^2 sec sterad. The x-ray cosmic background is ~7.5 photon/cm^2 sec sterad in the spectral region from 8 to 12 Å. In the vicinity of the Moon the corpuscular radiation of electrons of solar origin with energy $E \geq 50$ keV was registered, reaching a flux of $\sim 1 \times 10^3$ particles/cm^2 sec sterad. The intensity of the flux correlates well with the index of geomagnetic disturbance A_p. (tr-auth)

29313 TEST OF THE MEASUREMENT OF THE COSMIC RADIATION IN ARTIFICIAL SATELLITES. Zlotin, G. N.; Lyutenko, V. F.; Skryabin, N. G.; Shafer, Yu. G.; Yarygin, A. V. Kosm. Issled., 6: 88-99(Jan.-Feb. 1968). (In Russian).

In February–March 1964 simultaneous measurements were made of the cosmic radiation by means of identically calibrated apparatus on ISZ Cosmos-19, launched August 6, 1963, and similar to that of the ISZ Cosmos-25, launched February 27, 1964, to the same orbit as Cosmos-19. The results of these simultaneous observations are reported. The methods for the analysis of the continuous measurements in the two sputniks, interchangeable with each other in orbit, for the purpose of studying the variation of the cosmic radiation, are reported. (tr-auth)

29314 UPPER LIMIT OF THE CONTENT OF ANTINUCLEI IN COSMIC RADIATION. Ivanova, N. S.; Gagarin, Yu. F.; Kulikov, V. N. Kosm. Issled., 6: 83-7(Jan.-Feb. 1968). (In Russian).

On the basis of the study of nuclear emulsions, exposed at heights of 300 km, and of the investigation of all multicharged particles coming to rest in the emulsion and all interactions, caused by multicharged particles, the upper limit of the quantity of antinuclei in the composition of cosmic radiation was evaluated. Corrections to the difference in the cross section of the interaction of nuclei and antinuclei in the emulsion and to the secondary emission of some fragments of multicharged particles coming to rest were taken into consideration during the determination of the upper limits of the quantity of antinuclei. The value of the upper limit was $\bar{n}/n < 0.59\%$ of the multicharged components of primary cosmic radiation. (tr-auth)

29315 RADIAL GRADIENT OF COSMIC RADIATION MEASURED BY MARINERS 2 AND 4. Anderson, H. R. (Rice Univ., Houston, Tex.). J. Geophys. Res., 73: 2897-2909(May 1, 1968). (NP-17318).

The ionization rate and omnidirectional flux of radiation in interplanetary space were measured by similar ion chambers and GM tubes on Mariners 2 and 4 during September–December 1962, and November 1964 to March 1965, respectively. The energy threshold (determined by 0.2 g/cm^2 of wall material) was 10 MeV for protons. Average measured values were 681 ion pairs/sec cm^3 STP air and 2.89 particles/cm^2 sec in September–October 1962, and 984 and 4.29 in December 1964 to January 1965. Daily averages of ionization when the spacecraft was near Earth correlate with the Ottawa neutron monitor with a coefficient of 0.6 to 0.8, and with the IMP/OGO Geiger monitor (available for Mariner 4 only) with a coefficient of 0.94. Using these monitors to remove temporal variations, the following radial gradients were calculated:

Mariner 2, 1962		
Ottawa Monitor	5.6 to 12.7%/AU	1.0 to 0.7 AU
Mariner 4, 1964–1965		
Ottawa Monitor	14 to 22	1.0 to 1.28 AU
IMP/OGO Monitor	5.2 to 8.4	

The most accurate result was derived using the IMP/OGO monitor for a reference. If data from it were available in 1962, it is estimated that a "true" gradient of 12 to 27%/AU would be derived. (auth)

29316 CORRECTION OF COSMIC-RAY ENERGY SPECTRA FOR INSTRUMENTAL NOISE. Judge, R. J. R. (National Research Council of Canada, Ottawa). Can. J. Phys., 46: 907-8 (Apr. 1, 1968).

A mathematical method is described for the correction of energy spectra of cosmic-ray particles for the effects of scattering by spectrometer material and for errors in trajectory determination. The advantage of applying such corrections lies in the more accurate construction of incident spectra and hence better comparison with theoretical models. (auth) (Canada)

29317 STUDY OF THE ISOTOPIC COMPOSITION OF LOW-ENERGY HYDROGEN AND HELIUM NUCLEI IN THE PRIMARY COSMIC RADIATION. Badhwar, Gautam Dev. New York, Univ. of Rochester, 1967. 175p.

Thesis.

The results obtained from two balloon flights of a $dE/dx \times E$ counter–telescope, designed to measure the isotopic composition of low energy primary cosmic-ray hydrogen and helium nuclei are presented. The differential energy spectra of protons, deuterons, ^3He and ^4He in the approximate energy range of 60 to 220 MeV/n was obtained. The results indicate a constant ratio of $p/^4He$ of 4.3 ± 1.0 as a function of energy per nucleon in the above energy region. An upper limit of 0.25 on $^2H/^4He$ has been obtained at 150 MeV/n. This indicates, on the basis of a simple slab approximation, an upper limit of 6 g/cm^2 of hydrogen traversal by the primary radiation at this energy. A ratio of $^3He/^3He + {}^4He = 9.4 \pm 1.7\%$ was obtained in the energy range of 78 to 220 MeV/n. From a comparison of proton and helium spectra obtained in the experiment with the existing data for 1965, it is found that a modulation function proportional to $R\beta$ is favored over other forms

predicted by Parker's model. The demodulated $^3He/^3He + ^4He$ using an $R\beta$ modulation function, gives a traversal of 2.7 ± 0.5 g/cm^2 of hydrogen on the basis of a slab model in which ionization loss is taken into account. (Diss. Abstr.)

Direct Energy Conversion

Refer also to abstract 27797.

29318 ELECTRICAL PARAMETERS OF THE DC MHD GENERATOR WITH VARIOUS ELECTRICAL CONNECTIONS OF ELECTRODES. Celinski, Zdzislaw (Inst of Nuclear Research, Warsaw). Rozpr. Elektrotech., 14: 9-33(1968). (In Polish).

The electrical parameters of a dc MHD generator with segmented electrodes were determined for various electrode connection systems. Constant gasdynamic parameters, constant channel cross section and uniformity of the electric fields and current density were assumed. The "internal" (current density, electric fields, power density etc.) and "terminal" (current, terminal voltage, electric power, internal resistance, etc.) electrical parameters were calculated. The considerations were illustrated by a numerical example. (auth)

29319 NUCLEAR THERMIONIC CONVERSION: SIRENE 302 EXPERIMENT. Devin, B.; Bliaux, J. (CEN, Saclay, France). Bull. Inform. Sci. Tech. (Paris), No. 123, 47-58(Feb. 1968). (In French).

After the promising laboratory life test results in 1966–1967, the Physical Electronics Service in Saclay has carried its work on the in-pile reliability of nuclear thermionic converters. The Sirene 302 experiment described here is the first of a series of in-pile experiments using cylindrical sheathed-emitter converters of 100-W output power: the converter has been operating for 1650 hours with an efficiency of 11% and no performance decrease. From these experimental statistical results, it should be possible to define the best elementary module adapted as a function of the thermionic reactor application. (auth)

29320 ENERGIE-DIREKTUMWANDLUNG. (Direct Energy Conversion). Euler, Karl Joachim (ed.). Thiemig-Taschenbuecher, Band 10. Muenchen, Verlag Karl Thiemig KG, 1967. 371p. DM 26.80.

Nine review papers on direct energy conversion are included, namely: technical problems of direct energy conversion; photovoltaic energy conversion; thermoelectric converters; the present state of thermionic converters; radionuclide batteries; problems and status of the direct conversion of chemical to electrical energy; energy conversion in MHD generators; MHD nuclear power stations; and the prospect of direct energy conversion in large power plants. Extensive references are given at the end of each paper. (M.H.R.)

29321 THERMIONIC CONVERSION FOR SPACE AUXILIARY POWER GENERATION. Voorhees, Bertram G. (General Electric Co., Pleasanton, Calif.). Chem. Eng. Progr., 63: Symp. Ser., No. 75, 110-16(1967).

A summary is presented of the state of the art of the theory of the thermionic converter and of power output and efficiency performance levels which have been measured with operating converters. The application of thermionic conversion for space power generation is surveyed. For smaller space power systems the use of solar heating and radioisotope heating with thermionic converters is cited as of particular significance. For large systems the use of nuclear reactor heating is reviewed. Four nuclear thermionic concepts are compared and the two most promising are described more completely. The status in key research and development areas is summarized. (auth)

29322 SURVEY OF ELECTRIC POWER PLANTS FOR SPACE APPLICATION. Shure, Lloyd I.; Schwartz, Harvey J. (National Aeronautics and Space Administration, Cleveland). Chem. Eng. Progr., 63: Symp. Ser., No. 75, 95-105(1967).

This paper reviews the broad spectrum of power plants that are currently under development for space use including solar cells, batteries, fuel cells, thermoelectric generators, thermionics, and nuclear and solar mechanical systems. These systems are described in terms of their similarities to conventional devices rather than their differences. In almost every case, it can be shown that the concept being used, whether new or old, came into being because of its commercial potentiality rather than space power requirements. However, the space program has supplied the impetus for the research and development now being conducted to improve and understand these existing techniques. (auth)

29323 THE MHD GENERATION OF ELECTRICITY. (to Siemens-Schuckertwerke Aktiengesellschaft). British Patent 1,111,079. Apr. 24, 1968. Priority date Sept. 25, 1965, Germany.

Magnetohydrodynamic generation apparatus is described which comprises the following: an MHD generator channel including opposed generation electrodes; a combustion chamber operable under pulsating constant-volume combustion conditions and connected with the channel for supplying a gaseous operating medium; and a laser device connected with the combustion chamber and operable periodically so that when a combustible mixture is supplied periodically to the combustion chamber, it ignites the combustible mixture so that the combustion chamber operates under the said conditions. (M.H.R.)

29324 AN INTRODUCTION TO DIRECT ENERGY CONVERSION. Coombe, R. A. London, Pitman, 1968. 200p. 45s.

The subject is treated under the following main headings: introduction; MHD generation; thermionic generation; thermoelectric generation; fuel cells; other conversion processes (radiation cells, ferromagnetic generation, ferroelectric generation, controlled thermonuclear reactions). (UK)

Fluid Physics

29325 BOUNDEDNESS OF MAGNETOHYDRODYNAMIC FLOWS. I. Arora, Kasturi L. (Punjab Engineering Coll., Chandigarh, India). J. Math. Anal. Appl., 21: 608-17(Mar. 1968).

The stability of hydromagnetic flows in a region bounded by a single nonconducting surface is investigated theoretically for large values of the Reynolds number. An applied magnetic field transverse to the flow and nonuniform electric conductivity are assumed. (A.G.W.)

29326 BIDIMENSIONAL FLOW IN A PLASMA ACCELERATOR WITH PROGRESSIVE WAVES. Peyret, Roger (Univ., Paris). J. Mec., 6: 481-508(Dec. 1967). (In French).

The nonstationary bidimensional flow in a channel of an electrically conducting fluid exposed to the action of a progressive electromagnetic field was studied in a linearized theory obtained by supposing the electromagnetic effects sufficiently weak. The Reynolds magnetic number is assumed small; the effects of the field induced in the first approximation are however considered during the study of the flow in mean value in time. These induced fields are neglected in the calculation of the nonstationary flow. (tr-auth)

29327 END EFFECT PROBLEMS OF THE CONDUCTING FLUID FLOW IN THE PRESENCE OF LONGITUDINAL MAGNETIC FIELD. Kozyrenko, V. E. Magn. Gidrodin., Akad. Nauk Lat. SSR, No. 2, 50-60(1967). (In Russian).

Solutions are obtained for the end problems in flow of conducting fluids or gases in plane channels in which both walls are symmetrically bent in the direction of the flow, distributed in external constant magnetic fields with small but finite Re_m. Calculations were also made of the distribution of heat exchange and electrical current density along the effective area of MHD channels. (tr-auth)

29328 SLOW FLOW OF A VISCOUS AND CONDUCTING FLUID AROUND A SPHERICAL SHELL IN THE PRESENCE OF A MAGNETIC FIELD. Levy, Therese (Faculte des Sciences, Paris). J. Mec., 6: 529-45(Dec. 1967). (In French).

The stationary movement of an incompressible viscous conducting fluid around a crossed sphere in the presence of a magnetic field is considered. The flow and the magnetic field at infinity are uniform and parallel. The problem is put into an equation for the case where the Reynolds number and the Reynolds magnetic number are small. In the case of small Hartmann numbers, the solution of the problem is given up to the third order by using the method of small perturbations; this method necessitates the reconciliation of two asymptotic developments, one varied near the body and the other in the vicinity of infinity. The variations of the drag exercised on the sphere are studied as a function of the magnetic permeability of the shell, its thickness, and the Hartmann number. (tr-auth)

29329 MAGNETOFLUIDDYNAMIC DRAG MEASUREMENTS ON SEMI-INFINITE BODIES IN ALIGNED FIELDS. Suzuki, Bob Hiro. Pasadena, Calif., California Inst. of Tech., 1967. 116p. Thesis.

Experiments are described in which measurements were made of the drag of semi-infinite bodies moving parallel to a uniform magnetic fluid in a conducting fluid. Two of these bodies were moderately streamlined half bodies and a third was a blunt half body. The drag coefficients of all three bodies were found to in-

crease monotonically as a function of the interaction parameter, N. This parameter was varied in the experiments from 0 to about 24. The drag coefficients of the streamlined half bodies were found to increase linearly with N for $N \leq 0(1)$ in agreement with a simple theory based on a calculation of the Joule dissipation. On the other hand, for the same range of N, the drag coefficient of the blunt half body was found to increase negligibly from its zero-field value of 0.66. For $N \gg 1$, the drag coefficients of all three bodies were of 0(1) and appeared to be asymptotically converging to some common limiting value. Although the drag could not be calculated for large, finite values of N, an inviscid theoretical model of the flow is described from which it is concluded that the drag coefficient of any half body must approach unity as $N \to \infty$. In addition to the experiments with the semi-infinite bodies, experiments are also described in which measurements were made of the nonmagnetic drag of impulsively started flat disks. Some unexpected and interesting transient variations in this drag were observed and are attributed to the vortex formation process in the wake. (Diss. Abstr.)

Geophysics

Refer also to abstract 28984.

29330 AIR DENSITIES IN THE LOWER THERMOSPHERE FROM JET RADII. Golomb, D.; Good, R. E.; Mabee, R. S. (Air Force Cambridge Research Labs., Bedford, Mass.). J. Geophys. Res., 73: 3017-23(May 1, 1968).

A jet of gas released into the air from a supersonically moving vehicle expands until the thrust force of the jet is balanced by the drag force. Since the drag is a function of vehicle velocity, ambient density, and jet radius, the ambient density can be measured from known thrust, velocity, and jet radius. Jet radii were obtained from photographs of luminous nitric oxide trails. In the first measurements, only the 110- and 130-km region was covered, but the method appears feasible in the 90- to 140-km region. (auth)

29331 ALOUETTE 1 AND 2 OBSERVATIONS OF ABRUPT CHANGES IN WHISTLER RATE AND OF VLF NOISE VARIATIONS AT THE PLASMAPAUSE: A SATELLITE-GROUND STUDY. Carpenter, D. L. (Stanford Univ., Calif.); Walter, F.; Barrington, R. E.; McEwen, D. J. J. Geophys. Res., 73: 2929-40(May 1, 1968).

Broadband vlf recordings on satellites Alouette 1 and 2 frequently reveal an abrupt spatial cutoff in whistlers propagating on magnetospheric paths from the conjugate hemisphere. In a typical case, the observed count of well-defined whistlers drops suddenly to zero within 10 to 100 km as the satellite moves poleward near invariant latitudes of about 60°. The whistler cutoff is frequently accompanied by a "breakup" in the lower hybrid resonance (LHR) noise band, involving abrupt frequency and bandwidth changes as well as a transition from a smooth to an irregular appearance on frequency-time records. In each of 12 cases of simultaneous Alouette 1 observations and ground whistler data from Eights, Antarctica, on the "knee" position, a close spatial relation was found between the whistler cutoff and the position of the plasmapause. In a typical Alouette–Eights comparison, the subsatellite point at the cutoff was less than 1000 km in a generally eastward direction from Eights. Events ranged from 52° to 66° invariant latitude and were observed in the interval 0100–1030 LT. A systematic small offset between the plasmapause position calculated from whistlers and the invariant latitude of the cutoff or noise breakup observed on Alouette may possibly be attributable to magnetospheric plasma current effects. Alouette 1 and 2 statistics from 27 occurrences of the cutoff reveal a variation of cutoff position with magnetic disturbance that is similar to the known behavior of the plasmapause, the cutoff being observed at lower invariant latitudes during periods of increased disturbance. (auth)

29332 ALTITUDE PROFILE OF THE INFRARED ATMOSPHERIC SYSTEM OF OXYGEN IN THE DAYGLOW. Evans, W. F. J.; Hunten, D. M.; Llewellyn, E. J.; Jones, A. Vallance (Kitt Peak National Observatory, Tucson, Ariz. Univ. of Saskatchewan, Saskatoon). J. Geophys. Res., 73: 2885-96(May 1, 1968).

The altitude profile of the infrared atmospheric system of oxygen at 1.27 μ in the dayglow was measured using a two-channel filter photometer flown to an altitude of 128 km over White Sands, New Mexico, at a solar elevation of 14.5° in October 1966. The emission peaks at 49.5 km and the maximum volume emission rate is 1030 kR/km. The total emission intensity of 21 MR is in agreement with that of balloon-borne observations. The main emission layer agrees well with that predicted from an excitation mechanism of the photolysis of ozone in the Hartley continuum. There is some excess emission above 80 km, and three possible explanations are considered: additional ozone, enforced fluorescence via the $^1\Sigma$ level, and recombination of atomic oxygen. A combination of these can explain the observations, but which ones are most important cannot be decided. The amounts of metastable O_2 observed above 70 km are sufficient to provide an important source of ionization and of NO in the lower D region. (auth)

29333 BRILLOUIN SCATTERING IN PLASMAS AS APPLIED TO IONOSPHERIC IRREGULARITIES. Sato, Tetsuya (Kyoto Univ.). J. Geophys. Res., 73: 2941-9(May 1, 1968).

Theory of Brillouin scattering in plasmas, i.e., nonlinear interaction of electromagnetic waves with longitudinal (plasma) waves, is developed and applied to the ionospheric irregularities produced by a plasma instability. As a result, characteristic features appearing in vhf radar echoes from the equatorial E region seem to be plausibly explained. Above all, it is found that the main peak echoes and the small image echoes are well interpreted as arising from the phase-matched and mismatched scatterings by unstable ion-acoustic waves, respectively. Furthermore, Dougherty and Farley's interpretation of broad spectra at low frequencies is criticized, and an alternative interpretation is made by introducing another instability, i.e., cross-field instability. (auth)

29334 CALCULATED MODE CONVERSION AT THE SUNRISE BOUNDARY IN THE EARTH–IONOSPHERE WAVEGUIDE. Wait, J. R. (ESSA Research Labs., Boulder, Colo.). Electron. Lett., 4: 131-2(Apr. 1968).

Mode conversion of vlf radio waves in the Earth–ionosphere waveguide is considered. It is indicated that the transition distance Δd between day and night may be deduced, in a semiquantitative manner, from the observed fading characteristics. Values of Δd in the range 300 to 700 km are suggested. (auth) (UK)

29335 CHARGED-PARTICLE TEMPERATURES AND CONCENTRATIONS IN THE EARTH'S EXOSPHERE. Colin, Lawrence; Dufour, Stuart W. (Ames Research Center, Moffett Field, Calif.). J. Geophys. Res., 73: 2967-84(May 1, 1968).

Under the assumption that the Earth's magnetospheric plasma between 800 km and the plasmapause is in diffusive equilibrium, charged-particle temperatures and concentrations throughout the region are estimated from experimental electron concentration and scale-height data near the base of the region. Using various plausible models of electron and ion temperature distributions, relative abundances of oxygen, helium, and hydrogen ions near the base level as functions of dip latitude are computed. Ion temperatures and temperature gradients are also deduced. Experimental data employed in the analysis include Alouette 1 mid-latitude electron concentration profiles, Explorer 22 electron temperature data, and equatorial electron concentration profiles deduced from whistler observations. It is found that daytime temperature gradients of 1 to 2°K/km near 30° dip latitude at 1000 km and decreasing with latitude must exist along the field lines for the experimental data to be compatible with thermal equilibrium and a constant temperature gradient above 800 km. For unequal electron and ion temperatures, lower temperature gradients suffice. The relative abundance of hydrogen (oxygen) ions at 1000 km decreases (increases) dramatically with latitude, while the helium abundance shows little systematic variation. The results compare favorably with independent measurements of ion temperature and composition, lending confidence in the basic diffusive equilibrium assumption. (auth)

29336 DAY AIRGLOW. Noxon, J. F. (Harvard Univ., Cambridge, Mass.). Space Sci. Rev., 8: 92-134(Mar. 1968).

Observation and interpretation of day airglow-emission features originating in the Earth's upper atmosphere are reviewed; there is an accompanying discussion of techniques used to obtain the dayglow spectrum. (auth)

29337 DISCUSSION OF PAPER BY R. W. FREDRICKS, E. W. GREENSTADT, AND C. P. SONNETT, "MAGNETODYNAMICALLY INDUCED AMBIGUITY IN THE DATA FROM TILTED, SPINNING FLUXGATE MAGNETOMETERS: POSSIBLE APPLICATION TO IMP 1." Ness, Norman F. (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res., 73: 3077-80(May 1, 1968).

It is the purpose of this letter to clarify matters regarding the IMP 1 data, in view of the questions raised by Fredricks, Greenstadt, and Sonnett(1967), and to resolve the apparent differences with other experiments to which Fredricks et al., allude in attempting to substantiate their argument. A rebuttal by Fredricks, Greenstadt, and Sonnett is included. (W.D.M.)

29338 DISTRIBUTION OF ATMOSPHERIC IONIZATION IN THE REGION 15° TO 30° SOUTH LATITUDE. Jones, K. L.

(Univ. of Queensland, Brisbane). Planet. Space Sci., 16: 385-94(Apr. 1968).

An investigation was made of the horizontal and vertical distribution of ionization in the ionosphere near Brisbane (27.5°S., 152.5°W.) using Faraday rotation observations of Beacon Satellites and ground based ionosonde records. Considerable variability in electron content was observed, which was not due to solar effects. Evidence indicates that the main cause of this, during the period of observation, was variation in the recombination rate of ionization due to the ionosphere being formed at varying heights in the neutral gas. (auth) (UK)

29339 DIURNAL AND SEASONAL LATITUDINAL VARIATIONS IN THE UPPER ATMOSPHERE. Jacchia, Luigi G.; Slowey, Jack W. (Smithsonian Astrophysical Observatory, Cambridge, Mass.). Planet. Space Sci., 16: 509-24(Apr. 1968).

The variations with solar and geomagnetic activity were eliminated by the use of appropriate models, and the diurnal variation was isolated in the densities derived from the drag of seven artificial satellites with perigees between 250 and 650 km. An analysis of the diurnal variations leads to the following conclusions: (A.) Contrary to previous suggestions, the diurnal bulge does migrate in latitude in phase with the subsolar point at all heights. (B.) The diurnal bulge peaks at 2 p.m. local solar time (LST) irrespective of solar activity; the minimum density occurs between 3 and 4 a.m. (C.) The amplitude of the diurnal variation appears to fluctuate in a manner that cannot be entirely accounted for by variations in solar activity. (D.) The significant high-latitude residuals from the diurnal-variation model observed on the drag of Explorer 19 and Explorer 24 may be explained by the formation at exospheric heights of a region of greater helium density above the poles during the winter months, caused by a seasonal variation in the height of the turbopause. (auth) (UK)

29340 DENSITY SCALE HEIGHTS AT SUNSPOT MAXIMUM AND MINIMUM FROM SATELLITE DATA. Moe, Kenneth; Klein, David; Maled, George; Tsang, Louis. Planet. Space Sci., 16: 409-17(Apr. 1968).

Density scale heights, H_ρ, are derived by a new method, which utilizes the spin decay of paddlewheel satellites in highly eccentric orbits. The results are compared with H_ρ obtained by other satellite methods, and with those given by the Harris and Priester 1964 Model Atmosphere. Equations are derived for the calculation of H_ρ from spin decay and x-ray absorption. The gradient of H_ρ is calculated for the first time from the drag on a single satellite (IMP 2). Although a trend with solar activity can be seen clearly in the best data, the most obvious conclusion is that it is, in general, very difficult to determine density scale heights accurately. The best method so far developed for obtaining annual averages is the method of King-Hele, and the best method of obtaining averages over a few days is to use the spin decay of paddlewheel satellites in highly eccentric orbits. The accuracy of these two methods appears to be 5 to 10%, if the possible variation in drag coefficient is ignored. (auth) (UK)

29341 DOTTED PEARL MICROPULSATIONS. Dowden, R. L. (Univ. of Otago, New Zealand). J. Geophys. Res., 73: 2995-3004(May 1, 1968).

Spectrograms of pearl (Pc 1) micropulsations show dotted rising tones. It is suggested here that the dot structure is due to interference between the two components of a double tone or "hook." The observed dot structure could be produced by a nonconvective cyclotron instability of protons of about 100-keV energy and 60° pitch angle. (auth)

29342 DUCTED WHISTLER-MODE PROPAGATION IN THE MAGNETOSPHERE: A HALF-GYROFREQUENCY UPPER INTENSITY CUTOFF AND SOME ASSOCIATED WAVE GROWTH PHENOMENA. Carpenter, D. L. (Stanford Univ., Calif.). J. Geophys. Res., 73: 2919-28(May 1, 1968).

A large class of ducted magnetospheric whistlers exhibits an upper intensity cutoff at which the wave amplitude decreases by >10 db within a fraction of a kHz. A preliminary study, based in large part on whistlers recorded at Eights, Antarctica (L ~ 4), indicates that the ratio of cutoff frequency to whistler noise frequency f_{c0}/f_n is invariant with respect to path equatorial radius, local time, and magnetic activity. Measurements on 541 whistler components propagating in the plasmasphere were such that $f_{c0}/f_n = 1.33 \pm 0.08$ for about 70% of the cases. The corresponding result for f_{c0}/f_{H0}, the ratio of cutoff frequency to minimum path gyrofrequency, is $f_{c0}/f_{H0} = 0.51 \pm 0.03$. (To relate f_n and f_{H0}, the approximate relation $f_n = 0.38\ f_{H0}$ was used, from Angerami's work on the diffusive-equilibrium model of the distribution of thermal ionization along the field lines in the plasmasphere.) The observed behavior of f_{c0}/f_{H0} is apparently controlled by a propagation effect and not by a resonant particle damping process, the propagation effect probably being the half-gyrofrequency upper limit on ducted whistler-mode propagation in tubes of enhanced ionization predicted by Smith. Spectrographic vlf records exhibit much evidence of wave growth in the 0.4 to 0.5 f_{H0} band, an example being the stimulation of noise at ~0.5 f_{H0} by both whistlers and a low-power (~100 watts) controlled source. A whistler-triggering event may include: an intensity maximum above the whistler noise, followed by a slight dispersion anomaly and the cutoff; a quasi-constant triggered noise tone with bandwidth <100 Hz, duration ranging from ~30 msec to >1 sec, and intensity comparable to that of the associated whistler. The noise tone itself does not usually exhibit dispersive whistler-mode echoing, nor does it exhibit an intensity cutoff as it rises in frequency through the 0.5 f_{H0} level. Earlier observations by Kimura of triggering of magnetospheric noise by ~1-sec, 10.2-kHz pulses from the Omega transmitter at Forest Port, New York, have been extended to show that the triggering is confined in space to a range of paths with minimum gyrofrequency within a few percent of twice the transmitted frequency. A similar tendency is evident in noise produced by high-power (~10^6 watts) transmitters. A crude ampligram analysis of the cutoff effect shows that in a typical example the whistler wave intensity drops roughly 20 db within a time interval <13 msec and a frequency interval <50 Hz. (auth)

29343 EFFECT OF SUNSPOT ACTIVITY ON F-REGION DRIFT SPEED AT WALTAIR. Jogulu, C.; Rao, B. R. (Andhra Univ., Waltair, India). Nature (London), 218: 259(Apr. 20, 1968).

The results of a correlation analysis of F2-region drifts for 6 years from IGY to IQSY are presented. Drift records from spaced receiver equipment on 4.2 to 5.6 MHz for winter months were analysed, and included 2.4-MHz nighttime reflexions. Round-the-clock observations were made for about 6 days. Average values of drift speeds are shown plotted for the decreasing solar cycle from 1957 to 1964. The apparent velocity, V_a, showed an initial decrease with solar activity, but as the IQSY was approached there was a marked increase in this parameter. The true velocity, V, increased continuously with decreasing solar activity, and the same was the case for the random velocity, V_c, the increase from IGY to IQSY being greater for the latter. From the overall behavior of these parameters a definite increase in velocity during years of low solar activity was indicated, a result opposite to that in the E region. The increase in horizontal drift in the F region during low solar activity can be explained if ion drag is regarded as the main retarding force. (UK)

29344 EMPIRICAL EVALUATION OF RADIAL DIFFUSION COEFFICIENTS FOR ELECTRONS OF 50 TO 100 keV FROM L = 4 TO L = 7. Kavanagh, Lawrence D. Jr. (Rice Univ., Houston, Tex.). J. Geophys. Res., 73: 2959-65(May 1, 1968).

Empirical values for radial diffusion coefficients were calculated for electrons in the range 50 to 100 keV from L = 4 to L = 7 on the basis of equilibrium fluxes determined from Explorer 12 data. It was assumed that the principal loss mechanism for these electrons is pitch-angle scattering by whistlers. The diffusion coefficients derived from the data are several orders of magnitude larger than that expected from Kellogg–Parker diffusion. Typical values for D_1 are 2 R_E/day at L = 4.5, 85 R_E/day at L = 5.5, and ~25 R_E/day at L = 6.5. Typical values for D_2 are 3 R_E^2/day at L = 4.5, 63 R_E^2/day at L = 5.5, and 11 R_E^2/day at L = 6.5. Also, a sharp peak in the value of D_2 occurs at L = 5.75, and D_1 changes sign at this point. It is suggested that large-scale magnetospheric electric fields, of order 1 or 2 mV/m and possibly arising from field-line merging in the geomagnetic tail, may be responsible for much of this diffusion. (auth)

29345 ESTIMATE OF THE NEGATIVE ION CONCENTRATION IN THE D REGION OF THE IONOSPHERE. Ivanov-Kholodnyi, G. S. (Inst. of Applied Geophysics, Moscow). Dokl. Akad. Nauk SSR, 177: 1328-9(Dec. 21, 1967). (In Russian).

Rocket measurements of electron concentration (n_e) at 60 to 100 km are universally accepted and coincide with the lower atmosphere measurements. However, various rocket measurements of ion concentrations (n_1^+ and n_1^-) differ by the order of 2 to 2.5 magnitudes. Moreover, the relative magnitudes of n_1^+/n_e and n_1^-/n_e are higher by the order of magnitude than the theoretical calculations which take into account the mechanism of negative ion formation and recombination. An attempt was made of evaluating the magnitude $l^- = n_1^-/n_e$ considering the ionospheric data on effective coefficient of α' recombination. Electron concentration variations in the D region are determined by the equation $dn_e/dt = q(1 + l^-) - \alpha' n_e^2$. The effective recombination coefficient α' is bound to the coefficient of dissociative recombination α^* and with the coefficient of mutual neutralization of positive and negative ions α_1 with the ratio $\alpha' = \alpha^* + \alpha_1 l^-$. Thus, using α' it is possible

to determine the magnitude $\bar{l}^{-}$. Published data on α' and the data obtained on the negative ion concentration at 50 to 80 km are analyzed. (R.V.J.)

29346 INDIRECT EXPERIMENTAL EVIDENCE FOR THE EXISTENCE OF HALL AND PEDERSEN CURRENTS IN THE AURORAL E REGION. Newell, R. E.; Abel, W. G. (Massachusetts Inst. of Tech., Cambridge). Nature (London), 218: 454-6(May 4, 1968).

The conductivity of the ionosphere can be expressed as a tensor containing the three components σ_0, σ_1 and σ_2 representing, respectively, conductivity along the magnetic field ("longitudinal"), along an applied electric field perpendicular to the magnetic field ("transverse" or Pedersen), and perpendicular to both the electric and magnetic fields ("Hall"). Two parameters which can be measured by means of radar, absolute intensity of reflected signal and its Doppler spectrum, have a certain three-dimensional distribution for a given "applied" electric field, which depends on the existence of both Hall and Pedersen currents. Some radar observations are described in which expected manifestations of the Hall and Pedersen currents appear, providing indirect experimental evidence for their existence. There appears to be no direct experimental evidence for the presence of the Pedersen current in the auroral zone; ground magnetometer data appear to be dominated by the Hall current. (UK)

29347 IONIZATION OF THE POLAR IONOSPHERE BY SOLAR COSMIC RAYS. Velinov, P. (Geophysical Inst., Bulgarian Academy of Sciences, Sofia). Compt. Rend. Acad. Bulg. Sci., 21: 19-22(1968).

The examination of a phenomenon such as the absorption of radiowaves in the polar cap calls for the recording of the absorption of cosmic rays. This was the procedure followed previously (Velinov 1967), where q(h) was calculated with a vertical flow of particles ($\theta = 0°$). Calculations were also made with inclined penetration ($\theta \neq 0°$). Experiments show, however, that most of the effect is caused by protons which are isotropically distributed in the upper hemisphere $\theta = (0, \pi/2)$. This is precisely how the problem was solved previously when assuming a certain macro-law of absorption. The results obtained so far are examined and an attempt is made to generalize them. (W.D.M.)

29348 IONOSPHERIC ELECTRON DENSITIES AND TEMPERATURES IN AURORA. Walker, J. C. G. (Yale Univ., New Haven); Rees, M. H. Planet. Space Sci., 16: 459-75(Apr. 1968).

Electron density profiles corresponding to chemical equilibrium, and electron temperatures corresponding to heating of ambient electrons by auroral secondaries were computed for five stable auroral arc systems with published height profiles of λ3914 volume emission rates. The maximum electron density varies approximately as the three-quarters power of the λ3914 intensity, while the maximum temperature varies remarkably little. For these five auroras the temperature maxima lie between 2920 and 3511°K and occur at altitudes between 330 km and 390 km. (auth) (UK)

29349 IONOSPHERIC WINDS OVER YUMA, ARIZONA, MEASURED BY GUN-LAUNCHED PROJECTILES. Murphy, Charles H. (Ballistic Research Labs., Aberdeen Proving Ground, Md.); Bull, Gerald V. J. Geophys. Res., 73: 3005-15(May 1, 1968).

The newly installed 420-mm smoothbore gun at Yuma Proving Ground, Arizona, is described with its associated ground instrumentation. With an improved ignition system, this gun has placed an 84-kg projectile at an altitude of 180 km. Twenty-four of these projectiles carrying liquid trimethyl aluminum have been used to measure ionospheric winds through the creation of luminous trails. Analysis of these trails shows the presence of quite large easterlies at 110 km and a general descent of the wind patterns through the night. Harmonic analysis of the wind components at fixed altitude shows periodic components that are 2 to 5 times larger than the mean components and predominate periods of 10 to 12 hours. Seventy-five percent of the trails showed a characteristic clockwise rotation of the velocity vector. The absence of these phenomena at Barbados and the observation of counterclockwise rotation of trails over Argentina show the need for a theory to explain this behavior and its dependence on latitude and the Earth's rotation. (auth)

29350 LARGE-SCALE ELECTRIC FIELD IN THE MAGNETOSPHERE. Obayashi, Tatsuzo; Nishida, Atsuhiro (Tokyo Univ.). Space Sci. Rev., 8: 3-31(Mar. 1968).

A review is given on the distribution and origin of the large-scale electric field in the magnetosphere and its influence on the dynamical behavior of the magnetospheric plasma. Following a general discussion on the gross structure of the magnetosphere and its tail, two principal electric field systems are deduced from ground-based geomagnetic variations. One is responsible for the polar substorm, the DP 1 field, which is closely associated with the activation of the auroral electrojet. The other is responsible for the twin current vortices, the DP 2 field, and this represents the general convective system set up in the magnetospheric plasma. The origin of these magnetospheric electric fields is possibly based in the domain of the solar wind interacting with the outer geomagnetic field. However, the mechanism, in which the energy is transferred, is still quite controversial. Several theories so far proposed are re-examined, and some modification of them are suggested to have a consistent understanding of these two types of electric fields. The effects of electric fields on magnetospheric plasma dynamics are described, such as the formation of the plasmapause, the acceleration and diffusion of energetic particles in the radiation belt. (auth)

29351 LATITUDINAL VARIATION OF ATMOSPHERIC DISTURBANCES. Sazonov, B. I. Tr. Gl. Geofiz. Observ., No. 211, 3-16(1967). (In Russian).

The latitudinal variation of atmospheric disturbances at the 500-mb level in the Northern Hemisphere was studied on the basis of recent data on the movement and focusing of cosmic-ray particles in the Earth's magnetic field. It is shown that, proceeding from the hypothesis concerning the presence of uniformly distributed sources of cosmic rays at heights of ±40° above the ecliptic, the mean latitudinal variation of atmospheric disturbances of tropospheric circulation with all its characteristics can be explained. All 6 characteristics, obtained on the basis of an analysis of the characteristics of cosmic-ray intrusions, are found in the latitudinal variation of tropospheric disturbances over the Northern Hemisphere. It is concluded that it is highly probable that the principal cause of disturbances of the mean and upper troposphere are focused fluxes of medium energy cosmic rays intruding into Stoermer's impact zones. The effect of solar activity on tropospheric circulation occurs through an intermediate link, i.e., through solar and galactic cosmic rays. (Meteorol. Geoastrophys. Abstr.)

29352 LOW-ENERGY ELECTRON SPECTRA IN THREE VISIBLE AURORAS. Reidy, W. P. (American Science and Engineering, Cambrige, Mass.); Hegblom, E. R.; Ulwick, J. C. J. Geophys. Res., 73: 3072-6(May 1, 1968).

Three rocket measurements of low-energy electron spectra made during visible aurorae with a high-resolution electrostatic analyzer are reported. One flight was made from Fort Churchill and two from Fort Wainwright. The analyzer was designed to measure the electron flux over the energy range from about 1 to 40 keV. (W.D.M.)

29353 MAGNETIC ACTIVITY DIFFERENCES BETWEEN THE TWO HEMISPHERES FOLLOWING THE SECTOR STRUCTURE OF THE INTERPLANETARY MAGNETIC FIELD. Siebert, Manfred (Institut fuer Geophysik, Goettingen, Ger.). J. Geophys. Res., 73: 3049-52(May 1, 1968).

In several articles of this journal observations on a systematic polarity pattern or sector structure of the interplanetary magnetic field have been reported. In the present letter, the detailed results obtained by Wilcox and Ness [1965] during the Bartels solar rotations 1784/85/86, were used for comparison with differences in the magnetic activity of the two hemispheres. (W.D.M.)

29354 MAGNETOSPHERIC TAIL AS A HYDROMAGNETIC WAVEGUIDE. Patel, V. L. (Univ. of Denver). Phys. Lett., 26A: 596-7(May 6, 1968).

Cutoff periods of hydromagnetic waves are calculated for the magnetospheric tail. (auth)

29355 NATURE OF STRATOSPHERIC WARMING. Sazonov, B. I.; Zorina, V. P. Tr. Gl. Geofiz. Observ., No. 211, 31-45 (1967). (In Russian).

New data on the deformation of the Earth's magnetic field and the penetration of soft cosmic rays of protons and electrons into the stratosphere are examined. Taking these data into account, it is possible to explain the principal space–time characteristics of stratospheric circulation on the 30-mb level. It is shown that a specific combination of solar and geophysical events precedes a sudden warming of the stratosphere. Solar cosmic rays brought to Earth in a magnetic trap are the chief cause of disturbances in the stratosphere. (Meteorol. and Geo. Abstrs.)

29356 NIGHT MEASUREMENT OF MESOSPHERIC OZONE BY OBSERVATIONS OF ULTRAVIOLET AIRGLOW. Reed, Edith I. (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res., 73: 2951-7(May 1, 1968).

The ozone densities between 40 and 68 km over Wallops Island, Virginia, were measured by observation of the night airglow in the 2400- to 3000-A region by use of data from rocket-borne

photometers. Above 68 km, the ozone densities were too low to be detected by this instrumentation, that is, less than 5×10^{10} molecules/cm^3. The expected nighttime enhancement of ozone was noted as an increase by a factor of 10 over daytime values at about 63 km. The airglow emission was found to originate above 87 km with a maximum emission rate at 93 km. (auth)

29357 NIGHTTIME CHANGES IN THE ELECTRON CONTENT OF THE IONOSPHERE. Titheridge, J. E. (Univ. of Auckland, New Zealand). J. Geophys. Res., 73: 2985-93(May 1, 1968).

The total electron content of the ionosphere was determined at Auckland (37°S) and at Invercargill (46°S) throughout each night from June 1965 to December 1966. Increases in total content were observed on nearly half the nights in winter but not in summer. Comparison with northern hemisphere results shows that this is a true seasonal change. A model assuming a constant source of ionization and a fixed loss rate was fitted to the measurements by a least-squares analysis. This showed that a nighttime influx of ionization also occurs in summer, although the increased density makes its effects less obvious. The influx is reduced at low latitudes and, possibly, at the equinoxes. Increases in magnetic activity have little effect on the nighttime source of ionization, but cause an increase in the recombination coefficient. (auth)

29358 NONCONJUGATE ASPECTS OF RECENT POLAR CAP ABSORPTION EVENTS. Sauer, H. H. (Inst. for Telecommunication Sciences and Aeronomy, Boulder, Colo.). J. Geophys. Res., 73: 3058-62(May 1, 1968).

Several high-latitude riometer observing sites in Alaska, Canada, and on the Antarctic continent are presently in operation. Riometer data obtained during recent PCA events are reported, and some aspects of the events that specifically indicate differing responses between computed conjugate locations and between hemispheres are examined. (W.D.M.)

29359 NOTE ON THE DETERMINATION OF ELECTRON CONTENT OF THE IONOSPHERE FROM IONOSPHERIC FARADAY EFFECT. Schodel, J. P. (Max-Planck-Inst. Aeronomie, Lindau uber Northeim, Ger. Inst. Ionospharenphy, Lindau uber Northeim, Ger.). Arch. Elek. Uebertrag., 20: 353-6(June 1966). (In German).

Some limitations for the calculation of the total electron content of the ionosphere deduced from the Faraday effect of the ionosphere are discussed, namely: (1) influence of different propagation paths of the ordinary and extraordinary rays of a radio wave, (2) consideration of the geometry of the measuring system satellite-fixed receiving dipole, (3) irregular structures of the ionosphere, and (4) consideration of the terrestrial magnetic field. The methods of evaluating the total electron content are established and some results are shown. (Electron. Abstr. J.)

29360 OUTER IONOSPHERE. Schmelovsky, K. H. (Heinrich-Hertz-Institut fuer Solar-Terrestrische Physik, Berlin). Space Sci. Rev., 8: 74-91(Mar. 1968).

The results from ionospheric beacon observations are compared with the theory of F layer and outer ionosphere. Near sunspot minimum the total electron content up to 1000 km at medium latitudes is 1 to 2×10^{17} m^2 in the afternoon and about 0.3×10^{17} m^2 at night. The diurnal and latitudinal variations are more irregular during summer than during winter. Near sunspot maximum the respective values are about 1.5×10^{17} m^2 at night, 6 to 7×10^{17} m^2 near winternoon, 4×10^{17} m^2 near summernoon. The complete theory of diffusion in a multi-ion plasma gives very complicated expressions. Simpler approximations can be found respectively. Some models were calculated numerically and the dependence of the total electron on the parameters of the balance equation is investigated. Comparison with experimental results shows, that some main features of the diurnal and latitudinal variations of the total electron content can be explained. The seasonal anomaly, the slow decrease in the late night hours and the large increase toward equator cannot be explained without additional assumptions. (auth)

29361 OBSERVATION OF THE EFFECTS OF THE LOCAL ACCELERATION OF ELECTRONS INSIDE THE MAGNETOSPHERE. Malyshev, A. B. Kosm. Issled., 6: 77-82(Jan.-Feb. 1968). (In Russian).

The results of the measurement of the intensity of electrons in a narrow peak, recorded during the flight of Kosmos-17 at $L \sim 2.5$, are analyzed. The character of the longitudinal motion of the electron intensity at the peak showed that at the height of the flight, electrons, being emitted at great heights along the lines of force with $L \sim 2.5$, were recorded. The phenomena recorded can be explained by the fact that the electrons, formed of narrow peaks at $L \sim 2.5$, were accelerated in the area of sharp jumps of the electron concentration. It is assumed that the mechanism for the acceleration of electrons at the boundary limits, formed by jumps of electron concentration, can play an important role in the formation of external radiation zones, assuring the intense generation of electrons with energy of several hundred keV. (tr-auth)

29362 Pc 1 FINE STRUCTURE PHASE SHIFT AT HIGH-LATITUDE CONJUGATE POINTS. Annexstad, John O.; Wilson, Charles R. (Univ. of Alaska, College). J. Geophys. Res., 73: 3063-5(May 1, 1968).

During Feb. 1967, three separate Pc 1 events were observed at both the high-latitude conjugate stations at Kotzebue, Alaska, and Macquarie Island. These stations are equipped with identical magnetometers, analog chart and magnetic tape recorders, and electronic clocks with a timing accuracy of ±0.5 sec. The sonograms of the same events recorded at both stations were examined by the method of transparent overlays. When the fine structured elements of simultaneous Pc 1's were coincident at both stations, the time axis was shifted about 120 sec in each case. (W.D.M.)

29363 PARTICLE HEATING EFFECTS ON THE UPPER F REGION. Cole, K. D. (La Trobe Univ., Victoria, Australia). Planet. Space Sci., 16: 525-8(Apr. 1968).

The idea was developed (by Nathan and Seaton), in considerable quantitative detail, that a flux of electrons of energy about 1 keV each, precipitating into the atmosphere, may be capable of heating the electrons of the upper ionosphere at night sufficiently to account for the high electron temperatures, yet generating less of the emissions of N_2^+ than is observed. It is one of the purposes of this note to show that the conclusion that "the discrepancy between optical and heating effects is completely removed" is not justified at this stage. Secondly, it is demonstrated that it is unlikely that the mechanism produces the stable auroral red arc. (UK)

29364 PLANETARY INDEX FOR F2 LAYER IONIZATION. Chaman, Lal. J. Inst. Telecommun. Eng., 12: 61-2(1966).

A new method of deriving a planetary index $(\Sigma\overline{f_0F2})_p$ for F2 layer ionization is described. It is shown that planetary F2 layer ionization exhibits remarkable seasonal enhancement with biannual maxima which occur regularly and persistently during the months of April and October every year. A correlation coefficient of 0.95 was found to exist between the observed values of $(\Sigma\overline{f_0F2})_p$ and those calculated on the basis of this planetary index and solar activity for the period January 1953 to July 1962. (indian Sci. Abstr.)

29365 REACTIONS OF He^+ WITH N_2 AND O_2 IN THE UPPER ATMOSPHERE. Maier II, William B. (Los Alamos Scientific Lab., N. Mex.). Planet. Space Sci., 16: 477-93(Apr. 1968).

Reactions of He^+ with N_2 and O_2 were studied, and experimental cross sections are given for (1) $He^+ + O_2 \rightarrow O^+ + O + He$, (2) $He^+ + N_2 \rightarrow N^+ + N + He$, and (3) $He^+ + N_2 \rightarrow N_2^+ + He$ for primary ion kinetic energies below 40 eV. These measurements are consistent with cross sections deduced from measured thermal rate coefficients and with the Langevin cross sections. The rate of neutralization of He^+ by reaction with N_2 is deduced from the Langevin theory to be 1.6×10^{-9} cm^3 sec^{-1}, and this rate coefficient appears to include both reactions (2) and (3). The available experimental data for reaction (3) can be represented by a cross section σ of the form $\sigma = 8 \times 10^{-16}\ E^{-0.71}$ cm^2, where E is the primary ion energy in eV, for $0.15 \leq E \leq 40$ eV. It is suggested that the rate coefficient for reaction (3) may be approximately 7×10^{-10} cm^3 sec^{-1} in the ionosphere; this reaction rate implies that roughly 3×10^7 N_2^+ are produced by reaction (3) per second per columnar cm^2 of the Earth's atmosphere. Nine electron volts of excess energy are available in reaction (3), which may, therefore, be a source of energetic He of considerable importance in the loss of helium from the Earth's atmosphere. Theoretical values for the concentration of He^+ in the ionosphere are presented. The agreement of this simple theory with the experimental numbers depends considerably upon the parameters used in the theory, but appears to be within the combined uncertainties of the theory and the experiments. (auth) (UK)

29366 RESONANCES IN THE IONOSPHERE MAGNETOPLASMA. Johnston, T. W.; Shkarofsky, I. P. (Radio Corp. of America, Montreal). RCA Eng., 11: 52-5(Dec-Jan. 1965-66).

ALOUETTE, the swept frequency, topside-ionosphere sounding satellite, detected ringing, evident as "spikes" on ionograms at certain frequencies. The RCA Victor Research Laboratories in Montreal have been closely involved in the subsequent study of these phenomena, which involve some extremely advanced and complex plasma theory, and which may be very valuable in developing more exotic diagnostic methods for space plasmas. These ringing phenomena proved to be the local plasma frequency, the transverse resonance frequency, and harmonics (up to the fifteenth) of the cyclotron frequency. Collisions being negligible, the classi-

cal Vlasov electron plasma dispersion equation is applicable, from which these particular ringing frequencies are easy to infer; but the complicating effects of orientation antenna size, time behavior, etc., require and are now undergoing advanced theoretical analysis. The ALOUETTE low-frequency noise receiver also detected characteristic frequency phenomena involving ions associated with the electron–ion hybrid frequency and the zero-gyration electron–ion frequency. This paper summarizes this work and includes a bibliography of the pertinent literature in the field. (Electron. Abstr.)

29367 SEARCH FOR LOW-ALTITUDE ACCELERATION MECHANISMS DURING AN AURORAL SUBSTORM. McDiarmid, I. B.; Budzinski, E. E. (National Research Council of Canada, Ottawa). Can. J. Phys., 46: 911-21(Apr. 15, 1968). (NRCC–9955).

Two Black Brant rockets were fired simultaneously from Fort Churchill during an auroral substorm. Electron spectra and angular distributions were examined at altitudes up to 800 km in an attempt to observe the effects of acceleration or loss mechanisms acting on the particles at low altitudes. In particular, the variation of the pitch-angle distribution in the loss cone for electrons with energies greater than 40 keV and near 10 keV was examined as a function of altitude. It was found that the distributions within the loss cone at higher altitudes decreased more slowly with pitch angle than expected on the basis of the observed distributions at low altitudes if no forces other than the earth's magnetic field act on the particles. The discrepancy was larger for 10-keV electrons than for 40-keV electrons. It is concluded that mechanisms exist at altitudes below 800 km which can alter the magnetic moments and/or the energies of the particles. No satisfactory explanation of the observed discrepancy has been found. An attempt was made to interpret the results in terms of wave–particle interactions which could give rise to pitch-angle diffusion, but the magnetic-wave amplitude required is at least two orders of magnitude larger than observed values. (auth)

29368 SOME EVIDENCE CONCERNING THE DISTRIBUTION OF IRREGULARITIES RESPONSIBLE FOR RADIO AURORA. Lyon, G. F. (Univ. of Western Ontario, London). Planet. Space Sci., 16: 449-57(Apr. 1968).

During the summer of 1966 signal enhancements associated with auroral activity were observed on two 40-Mc bistatic scatter circuits whose geometry was such that the dependence of signal amplitude upon scattering angle could be investigated. During the early evening hours the signal amplitudes were consistent with the usually adopted models of weak scattering from irregularities in electron density. During the morning hours the signal amplitudes were quite inconsistent with the predictions of any model based upon a random distribution of scatterers. It is suggested that this is further evidence that the irregularities are the result of ion–acoustic waves generated by the auroral electrojet. (auth) (UK)

29369 STATISTICS OF POLAR AURORAS. Schroeder, W. Beitr. Geophys., 76: No. 1, 15-17(1967). (In German).

Investigation of visually observed auroras during the 1946 to 1951 period (sunspot maximum 1947.5) with respect to their redness is considered. It is shown that there exists a strong relation between maximal solar activity, geomagnetic conditions, and frequency of red auroras. (IAA)

29370 STUDY OF IONOSPHERIC CHARACTERISTICS AT TRIVANDRUM DURING HIGH AND LOW SUNSPOT ACTIVITY PERIODS. Rao, C. S. R.; Benjamin, P. (All India Radio, New Delhi). J. Inst. Telecommun. Eng., 12: 63-9(1966).

Analysis of ionospheric data obtained during low sunspot activity period corresponding approximately to the first half of IQSY at Trivandrum is considered. The diurnal and seasonal variation of f_0F2, hpF2, and fE_s are described. The N–h profiles obtained were utilized to study the diurnal and seasonal variations of electron density at different heights and the subpeak electron content of the ionosphere. The true height of maximum electron density are compared with those obtained by assuming a parabolic distribution. The above results are compared with those obtained during high sunspot activity and the similarities and differences pointed out. (Indian Sci. Abstr.)

29371 SURVEY OF LOW-ENERGY ELECTRONS IN THE EVENING SECTOR OF THE MAGNETOSPHERE WITH OGO 1 AND OGO 3. Vasyliunas, Vytenis M. (Massachusetts Inst. of Tech., Cambridge). J. Geophys. Res., 73: 2839-84(May 1, 1968). (MIT–2098-401).

Observations of electrons of energy 125 eV to ~2 keV with the OGO 1 satellite and of electrons of energy 40 eV to ~2 keV with OGO 3 (by means of modulated Faraday cup detectors) were used to investigate the low-energy electron population in the magnetosphere within the local-time range ~17 to ~22 hours. (TSS) (auth)

29372 TEMPERATURE AND DENSITY OF THE THERMOSPHERE IN THE PERIOD OF PROFOUND MINIMUM OF SOLAR ACTIVITY. Marov, M. Ya. Kosm. Issled., 6: 110-18(Jan.–Feb. 1968). (In Russian).

The results of the calculation of the temperature and density of the thermosphere at heights from 150 to 300 km with utilization of the measurement of the orbit parameters of ISZ, reduced to the size of the decimetric radio emission of the Sun as index of the solar activity $F_{10.7} = 65$ to 70×10^{-22} w/m^{2}Hz, are reported. It is shown that the altitude profile of the density agrees well with the static diffusion model of Yakkia at temperature T = 700°K and is 20 to 25% lower than the mean value recommended by the model of the First International Model of Standard Atmosphere CIRA. The evaluation of the temperature indicated the presence in this period of isotherms above approximately 250 km with $T_\infty = 700$°K and range of daily variations from 600 to 850°K. The possible reasons for the phase displacements in the character of the variation of the density from day to night between 200 and 260 km were analyzed. (tr-auth)

29373 TEMPORAL FEATURES OF HIGH-INTENSITY AURORAL MICROBURSTS. Brown, R. R.; Weir, R. A. (Univ. of California, Berkeley). J. Geophys. Res., 73: 3042-8(May 1, 1968).

In the magnetic disturbances accompanying the solar activity of late August–early September 1966, electron precipitation in the auroral zone reached very high levels, thus providing opportunities to examine aspects of fast time variations of auroral x-ray fluxes in some detail. The present note concerns temporal features of microbursts. The observations were obtained with an uncollimated NaI(Tl) scintillation counter launched from Fort Wainwright, Alaska, at 0800 UT on August 30, 1966. (W.D.M.)

29374 THEORETICAL TECHNIQUE FOR EVALUATING THE TIME-DEPENDENT EFFECTS OF GENERAL ELECTRODYNAMICS DRIFTS IN THE F2 LAYER OF THE IONOSPHERE. Baxter, R. G.; Kendall, P. C. (Univ. of Sheffield, Eng.). Proc. Roy. Soc. (London), Ser. A, 304: 171-85(Apr. 10, 1968).

A technique for solving the full global diffusion equation for the F2 layer, including electrodynamic "E × B" drift, is presented. This involves considering the form of the diffusion equation in axes moving with the electrodynamic "E × B" drift. In addition, it is shown how the region of integration, which involves complicated dipole geometry, may be mapped on to a semi-infinite rectangle. The method is illustrated by calculating world curves of electron density for a simple model atmosphere in which the electrodynamic "E × B" drift and the electron production are time dependent and the electron loss coefficient is time independent. The calculations are compared with previous experimental results and confirm electrodynamic lifting as one of the major factors controlling the dip equatorial F2 layer and the associated trough of ionization. (auth) (UK)

29375 TWILIGHT AND NIGHTGLOW SPECTRAL LINE SHAPES OF OXYGEN λ6300 AND λ5577 RADIATION. Biondi, Manfred A.; Feibelman, Walter A. (Univ. of Pittsburgh). Planet. Space Sci., 16: 431–43(Apr. 1968).

A pressure-tuned Fabry–Perot interferometer employing photoelectric detection was used to measure the oxygen λ6300 and λ5577 spectral line profiles during twilight and the night at the Airglow Observatory on Laurel Mountain, Pennsylvania. The infrared O(^{1}D) atom temperatures, ranging from ~600 to 1600°K, were compared with the predicted temperature variations using empirical models relating solar activity to exospheric heating, and agreement found on some nights, while substantial discrepancies (~400°K) were found on others. No evidence for or against a dissociative origin of the ^{1}D or ^{1}S oxygen atoms has been obtained from the line profiles observed to date, probably owing to rapid thermalization of any such excited atoms before radiation can occur. There is, however, a possible indication of F-layer wind velocities of ~400 m/s. (auth)

29376 VARIATIONS OF POLAR MESOSPHERIC OXYGEN AND OZONE DURING AURORAL EVENTS. Maeda, Kaichi; Aikin, A. C. (Goddard Space Flight Center, Greenbelt, Md.). Planet. Space Sci., 16: 371-84(Apr. 1968).

Temporal solutions are given of the photochemical equations describing the distribution of ozone and atomic oxygen in an oxygen atmosphere for the polar regions. Similar calculations are applied to auroral events, and indicate a strong dependence of mesospheric atomic oxygen on the intensity and energy spectrum of auroral electrons, which dissociate molecular oxygen. It is shown that there can be no significant atmospheric ozone and atomic oxygen modifications due to soft spectrum electron events which

appear to characterize most bright auroras. On the other hand, the hard spectrum auroral electrons which appear in most weak, quiet auroras should cause significant increases in the atomic oxygen and ozone concentration below 80 km, provided their flux is more than $10^6/cm^2$ sec. (auth) (UK)

29377 VHF BISTATIC AURORA BACKSCATTER COMMUNICATIONS: COMPARISON OF THE OBSERVATIONS WITH THE THEORY. Lange-Hesse, G.; Czechowsky, P. (Max-Planck Inst. Aeronomy, Ger.). Arch. Elek. Uebertrag., 20: 365-73(July 1966).

The geometry of the propagation path of vhf aurora backscatter communications between two different points is computed according to a theoretical model and compared with experimental observations. The computed curves in space along which the backscattering centers must be located (backscatter curves) coincide at least at one point with the simultaneous visual aurora display responsible for the observed backscatter communication. The computed maximum possible distance curves for this kind of communication are in reasonably good agreement with the observations. Observed deviations from these curves at greater distances can be explained mainly by magnetic dip angle variations during geomagnetic storms. The centers backscattering the vhf radio waves also coincide in space with the location of the S_q-current system (aurora current system) in sufficient approximation. (Electron. Abstr. J.)

29378 VHF REFRACTION BY VISIBLE AURORAL FORMS. Fremouw, E. J. (Stanford Research Inst., Menlo Park, Calif.); Lansinger, J. M. J. Geophys. Res., 73: 3053-7(May 1, 1968).

It has been found that certain isolated refraction events observed on interferometer records of a radio source can be identified with passage of individual auroral arcs across the radio line of sight. The simplicity of some of the patterns recorded with the interferometer and the obvious association with single auroral forms provide a basis for application of Gagnon's technique. The approach is to assume the refractive event to be caused by an ionospheric lens closely related to the observed auroral form, although not necessarily precisely coincident with it. The analysis, which is a model-fitting procedure, yields a partial description of the wavefront immediately after perturbation by the lens. Some characteristics of the lens then can be inferred. The results of analyzing two events observed at College, Alaska, in January 1966, are reported. (W.D.M.)

29379 INVESTIGATION OF ENERGETIC ELECTRON INTENSITIES IN THE EARTH'S OUTER RADIATION ZONE WITH OGO 1. Hills, Howard Kent. Iowa City, Iowa, Univ. of Iowa, 1967. 117p.

Thesis.

Observations of intensities of outer-zone electrons obtained with instrumentation borne on OGO 1 during the period September through December, 1964, are presented. Omnidirectional intensities near the magnetic equatorial plane are given for electrons of energy $E > 40$ keV, $E > 130$ keV, and $E > 2$ MeV, and are characterized by short-term variations superimposed upon an over-all long-term decrease. The pitch angle distributions of electrons ($E > 40$ keV and $E > 130$ keV) may be approximated by the function $\sin^n \alpha$ with n generally found to be less than or about unity throughout the outer zone ($3 \lesssim L \lesssim 7$). Computations of the effects of geomagnetic storms upon the distribution of intensities of these electrons with energies above the detector thresholds are summarized. These results are compared with observations in order to distinguish between adiabatic and nonadiabatic particle behavior. Adiabatic motions are shown to be capable of causing large temporal variations in electron intensities during a magnetic storm. (Disser. Abstr.)

29380 OMNIDIRECTIONAL FLUXES: EXPLORER 4 SATELLITE DATA, ARGUS EVENTS 1 AND 2. George, John Angelos. St. Louis, St. Louis Univ., 1967. 135p.

Thesis.

Two omnidirectional Geiger–Mueller counters flown on Explorer 4, satellite 1958ϵ, were used to obtain time histories of electron fluxes resulting from the Argus high-altitude nuclear explosions. Electrons, $E_e > 3$ MeV and $E_e > 7.6$ MeV, were observed in the region $L = 1.69$ to 1.76 and $L = 2.0$ to 2.25 for Argus events 1 and 2, respectively. The decay rate of Argus 1 is shown to follow a $t^{-1.13}$ law. Subsequent to the detonation of Argus 2, a broadening of the half-width ΔL by approximately 1.5 is observed in the Argus 1 shell, although the peak count-rate remained at $L = 1.72$, at least within experimental error, during the time of observation. The count-rate ratio of the unshielded to the shielded counter is found to decrease with time, most of the data points clustered about a $t^{-1.13}$ law. This indicates spectral changes with the time in apparent contradiction to earlier results of Jason rocket data. The magnetically disturbed days of September 3 to 5 had a marked effect (greater than 50% departure from the expected $t^{-1.13}$ law) on the decay rate of Argus 2. The maximum fluxes observed for the data analyzed were 4.6×10^6 cm^{-2} sec^{-1} (Argus 1, $L = 1.72$), 4.4×10^5 cm^{-2} sec^{-1} (Argus 2, $L = 2.11$). A three dimensional plot was made of true count rate versus B and L, to summarize the data analyzed for the unshielded G–M counter for Argus event 1. A critical review is made of possible mechanisms which would be effective in enhancing the atmospheric losses and explain the rapid decay of the Argus events. It is shown that hydromagnetic waves and whistler interactions resulting in the breakdown of the first adiabatic invariant are not, at least qualitatively, major mechanisms in removing Argus electrons. Adiabatic processes such as betatron acceleration and deceleration cannot be excluded in any detailed analysis of irreversible loss mechanisms. The effect of slow changes in the magnetic field upon the omnidirectional intensity of particles is considered and computations for the Argus time period show that the relative intensity could change by 15% due to the betatron acceleration alone. (Disser. Abstr.)

29381 SPECTRAL, SPATIAL, AND TEMPORAL VARIATIONS OBSERVED FOR OUTER-ZONE ELECTRONS FROM 10 TO 100 keV WITH SATELLITE INJUN 3. Fritz, Theodore Allan. Iowa City, Iowa, Univ. of Iowa, 1967. 202p.

Thesis.

Spectral, spatial, and temporal variations of outer zone electrons with energies from 10 to 100 keV observed with Injun 3 are presented. Electrons with $E_e \geq 40$ keV were constantly observed precipitating into the atmosphere for all latitudes, $\Lambda \geq 45°$. At latitudes below the high-latitude boundary, the flux of ≥ 40-keV electrons in the loss cone was observed to always be $\sim 10^{-2}$ that of the locally mirroring flux. There was usually a spike of precipitating ≥ 40-keV electrons at the high latitude boundary and the flux of ≥ 40-keV electrons was usually observed to approach isotropy over the upper hemisphere at the position of the satellite at this boundary. Large intensities of electrons with energies not much greater than 40 keV were observed precipitating into the atmosphere for $\Lambda \geq 65°$ during magnetically quiet periods and the position of the high-latitude outer zone boundary was observed to vary by $\Delta\Lambda \sim 7°$ while no magnetic activity was occurring. Strong observational support was found for the model of Taylor and Hones [1965] which adiabatically accelerates and then precipitates solar wind electrons in the auroral zone during magnetically active periods. The existence of a two-stream instability mechanism reported by Stix [1964] and discussed by Evans [1967] which can act during the intense ≥ 10 keV precipitation events was also given observational support. Evidence is presented for the existence of another mechanism which acts in the region of the satellite (200 km to 1000 km) almost constantly, directionally accelerates electrons with $E_e \leq 40$ keV toward the atmosphere, and produces isotropic electron pitch-angle distributions over the upper hemisphere at the position of the satellite predominantly at low altitudes right on top of the atmosphere for the region of the outer zone $\Lambda \geq 65°$. (Disser. Abstr.)

29382 VAN ALLEN RADIATION BELT AND ARGUS DIRECTIONAL FLUX DENSITY DISTRIBUTIONS, EXPLORER IV SATELLITE DATA. Manson, Donald Joseph. St. Louis, St. Louis Univ., 1967. 272p.

Thesis.

Directional radiation flux density distributions from data acquired in the inner Van Allen belt and in the ARGUS Events 1 and 2 shells by the satellite Explorer IV were analyzed and compared with the results of other investigators. Instrumentation, telemetry, and data reduction are discussed in detail. Space coordinate systems are presented and are related to the measurements necessary to determine the roll (or spin) and tumble motion of the satellite so as to determine its orientation with respect to the Earth's magnetic field in space as a function of time. This allows determination of the directional particle flux density relative to the magnetic field. Passes 414 and 427 of the satellite over Huntsville were analyzed in detail as examples of the complete determination of the orientation parameters at a point in space and time from which the subsequent orientation throughout the time of data acquisition can be calculated. Data from Explorer IV is presented in B and L coordinates for the first time. Unidirectional flux density perpendicular to B in the inner Van Allen belt was found to vary from 1.2×10^8 to 2.7×10^7 particles sec^{-1} cm^{-2} ster^{-1} for a variation of L from 1.35 to 1.61 earth radii. Maximum flux density $> 2.3 \times 10^8$ particles sec^{-1} cm^{-2} ster^{-1} was observed 1.8 hrs after Event 1 at $L = 1.7$. Exponential decay of maximum flux density perpendicular to B by one order of magnitude in 45 hrs was observed, but the data available are not sufficient to exclude a $1/t$ type decay. Data from the naturally and artificially injected radiation are fitted well by the function $J = KB^n$, where the average value of n is -7, for both the natural and the ARGUS data. An exception to the above $J = KB^n$ representation for the ARGUS shell 1.8 hrs after Event 1 (Pass 414 over Huntsville) was found in

which considerable departure from the ordinary disk-like shape of the radiation necessitated the analysis of each modulation of the count-rate separately along with comparison with the omni-directional count-rates. No such unusual effects were observed 1.87 hrs after Event 2 (L = 2.1) and the Event 1 radiation was found to be disk-like one day later (Pass 427 over Huntsville). (Disser. Abstr.)

29383 THE MAGNETIC FIELD AND ENERGY OF AN AXI-SYMMETRIC VAN ALLEN BELT. Chapman, S.; Kendall, P. C.; Swartztrauber, P. N.; Windle, D. W. Geophys. J. Roy. Astron. Soc., 15: 317-29(Apr. 1968).

In an earlier paper the magnetic vector potential of an axisymmetric distribution of azimuthal electric currents was expanded in a Legendre series. It was shown that the method may be used to study the magnetic field of a geomagnetic ring current of charged particles spiraling in a dipole field. The purpose of this further work is to determine the self-magnetic energy for various model ring current belts. The pitch angle parameter α commonly used in such models is taken to be constant. Other parameters are k_0, the distance (measured in Earth radii) of the maximum particle density from the center of the Earth, and g_1, g_2, constants such that the particle density is proportional to $\exp\{-g_1^2(R-k_0)^2\}$ for $R \le k_0$ and to $\exp\{-g_2^2(R-k_0)^2\}$ for $R \ge k_0$; here R denotes the radial distance from the Earth's center (measured in Earth radii) in the dipole equatorial plane. Numerical results are given within the range $-1 \le \alpha \le 5$, $2 \le k_0 \le 6$, $0.5 \le g_1 \le 3$, $0.5 \le g_2 \le 3$. The distribution of magnetic energy between the various harmonics is also given. (auth)

Low-Temperature Physics

Refer also to abstracts 28173, 28250, 28806, 29190, and 29594.

29384 (CERN-68-17) CONSTRUCTION OF A SUPERCONDUCTING TEST COIL COOLED BY HELIUM FORCED CIRCULATION. Morpurgo, M. (European Organization for Nuclear Research, Geneva (Switzerland)). May 13, 1968. 10p. Dep.

An experimental study was made of the forced cooling of superconducting coils by means of supercritical He circulated in hollow conductors. The design of the forced cooling system is described in detail. The conductor used to wind the test coil is a two-channel Al tube with Nb-Zr wires embedded in the middle; the test coil contains 16 double pancakes (each having 36 turns) electrically connected in series. The coil was operated at 3 to 4 atm and a pumping speed of 80 turns/min. The coil temperature was measured to be 4.7°K, and the current could be raised to 900 A (central field ~28 kG) with no dc voltage at the coil terminals. When the current was raised slightly above 900 A, a dc voltage was detected, and this voltage and the coil temperature increased with time. Equilibrium conditions could be re-established by reducing the current to 600 A. (D.L.C.)

29385 (PEL-159) ZERO SOUND AND SUPERCONDUCTIVITY AS PROTOTYPE OF THE MANY-BODY PROBLEM. van der Merwe, P. du T. (Atomic Energy Board, Pelindaba, Pretoria (South Africa)). Aug. 1967. 58p. Dep.

An account is given of the modern theory of superconductivity starting from the microscopic interactions between the conduction electrons and phonons. The properties of a many-particle Fermi system are studied at low temperatures. The physical basis of the theory of superconductivity is discussed, and a quantum mechanical treatment of the superconducting phase is given. The theory of the Fermi liquid at absolute zero is presented on the basis of Schwinger techniques. The method of structure analysis is introduced into the regime of the many-body problem. A new derivation of the Cooper phenomenon is given. The Green's function theory of superconductivity is developed at finite temperatures. Some of the recent developments such as the breakdown of the quasi-particle approximation, the Ginzburg-Landau equation, and Abrikosov flux lines, are mentioned. Analogies between the many-body problem and particle physics are discussed. (D.L.C.)

29386 (UCRL-18176) ac LOSS MEASUREMENTS IN SUPERCONDUCTING MAGNETS. Gilbert, William S.; Hintz, Roland E.; Voelker, Ferd (California Univ., Berkeley. Lawrence Radiation Lab.). Apr. 1968. Contract W-7405-eng-48. 24p. Dep. CFSTI.

Measurements have been made of energy lost in charging and discharging superconducting magnets containing NbTi material. An electrical multiplier technique has been developed for measuring these losses. Single-cycle losses can be determined with this method. Loss data have been obtained for peak magnetic fields ranging from a few kilogauss to 70 kilogauss. These measured losses are compared with theory. A new ordering effect, in which the cyclic loss depends on the previous magnetic history of the superconductor, has been found. (auth)

29387 A PARTIALLY STABLE 90-kG COMPOSITE SUPERCONDUCTING SOLENOID. Lindenbaum, Samuel D.; Becker, Joseph F. (Grumman Aircraft Engineering Corp., Bethpage, N. Y.). J. Appl. Phys., 39: 2627-8(May 1968).

From Applied Superconductivity Conference and Exhibition, Austin, Tex. See CONF-671116.

A superconducting solenoid, composed of an outer coil of A-25 (Nb-25 at.% Zr) wound on an inner coil of T-48B (Nb-48 at.% Ti), is described. The solenoid has a ½ in. bore, a length of 4.5 in., and o.d. of 4.3 in., and produces an axial field of 90 kG with a maximum current of 25 A(H/I = 3.6 kG/A). A discussion of coil-training effects is included. (auth)

29388 AUTOMATIC SUPERCONDUCTING SWITCHES. Laquer, H. L. (Los Alamos Scientific Lab., N. Mex.). Contract W-7405-eng-36. J. Appl. Phys., 39: 2639-40(May 1968). (LA-DC-8945).

From Applied Superconductivity Conference and Exhibition, Austin, Tex. See CONF-671116.

The design and testing of a simple automatic superconducting switch or current limiter is described. Reliable switches having switching currents up to 670 A at 4°K have been built for use with a flux pump. (auth)

29389 CRYOELECTRIC CONTENT-ADDRESSABLE MEMORIES USING FLUX-SHUTTLING NONDESTRUCTIVE READOUT. Keneman, S. A. (Radio Corp. of America Labs., Princeton, N. J.). J. Appl. Phys., 39: 2579-85(May 1968).

From Applied Superconductivity Conference and Exhibition, Austin, Tex. See CONF-671116.

The feasibility of large capacity content addressable memories (CAMs) using the flux-shuttling nondestructive readout (NDRO) technique and designed to handle the multiple response problem is investigated in this paper. A 4 × 4 CAM incorporating flux-shuttling cell and crossed-film cryotron logic circuitry were designed, fabricated, and tested. On the basis of the results of the tests performed, a highly efficient CAM was designed. The ultimate performance limits of the type of CAM designed are considered. (auth)

29390 CYLINDRICALLY SYMMETRIC SOLUTIONS OF THE GINZBURG-LANDAU EQUATIONS. Tholfsen, Paul; Meissner, Hans (Stevens Inst. of Tech., Hoboken, N. J.). Phys. Rev., 169: 413-16(May 10, 1968).

The Ginzburg-Landau equations have been solved for an isolated magnetic flux line enclosing a single flux quantum. The radial dependence of the magnetic field H, the order parameter n_s, the current density J, and the resulting free energy per unit length F/L are obtained for values of the Ginzberg-Landau parameter κ = 20, 5, 1.0, 0.5, and 0.2. For $\kappa \le 5$, the axial magnetic field H(0) is approximately given by $H(0) = 0.62\kappa^{-0.43}\sqrt{2}H_{cb}$. The maximum value of the current density is approximately $J = 0.33\sqrt{2}H_{cb}/\lambda$, where H_{cb} is the bulk critical field and λ is the superconducting penetration depth. (auth)

29391 $\partial T_c/\partial P$ FOR TECHNETIUM AND A COMMENT ON ITS SIGN IN RELATION TO THE OTHER TRANSITION METAL SUPERCONDUCTORS. Chu, C. W. (Univ. of California, San Diego, La Jolla); Gardner, W. E.; Smith, T. F. Phys. Lett., 26A: 627-8(May 6, 1968).

The pressure dependence of the superconducting transition temperature of technetium has been measured up to a pressure of 15 kbar and found to be $-1.25 \pm 0.05 \times 10^{-5}$ °K/bar. (auth)

29392 DYNAMIC FAULT TOLERANCE IN CRYOELECTRIC ARRAYS. Pritchard, J. Paul Jr.; Slay, B. G. Jr. (Texas Instruments Inc., Dallas). J. Appl. Phys., 39: 2588-91(May 1968).

From Applied Superconductivity Conference and Exhibition, Austin, Tex. See CONF-671116.

Properties peculiar to superconductive phenomena and derived devices permit operation of cryoelectric arrays containing failed elements. This fault tolerance extends throughout the operational life of the array and is therefore referred to as dynamic fault tolerance. A cryotron-gated, superconductive loop possesses three stable states: two with circulating current of opposite polarity and a third without circulating current. The latter can be paired with either of the circulating states to form a binary logic device which will fail safe to the noncirculating current state under all failure modes except short-circuit formation. Analysis of failure origin and technology redefinition has eliminated short circuitry as a failure mode in completed arrays. The requirements for implementation of dynamic fault tolerance are developed and illustrated in terms of successful experiences with a 20,000 gate cryoelectric array objective. (auth)

29393 3d ELEMENTS IN SUPERCONDUCTING PdSb. Geballe, T. H. (Bell Telephone Labs., Murray Hill, N. J.); Matthias, B. T.; Caroli, B.; Corenzwit, E.; Maita, J. P.; Hull, G. W. Phys. Rev., 169: 457-65(May 10, 1968).

Dilute solutions of CrSb and MnSb in PdSb are found to exhibit localized magnetic moments in both their superconducting and magnetic behavior. Solutions of other 3d element antimonides in PbSb are much weaker magnetically. The behavior of the dilute solutions bears a marked resemblance to the magnetic characteristics of the pure 3d-element antimonides. Both superconducting and heat-capacity data yield an s–d exchange integral of about 0.17 eV for the conduction-electron–Mn-ion interaction, and about 1.4 eV for the conduction-electron–Cr-ion interaction. (auth)

29394 FORMATION OF α PHASE IN SUPERCONDUCTING Ti-47 WT PERCENT Nb DURING HEATING IN AN ELECTRON MICROSCOPE. Vozilkin, V. A.; Rakin, V. G.; Buinov, N. N. (Inst. of Physics of Metal, Moscow). Fiz. Metal. Metalloved., 25: 372-4(Feb. 1968). (In Russian).

It is shown that an α phase with hexagonal lattice is formed in superconducting Ti–47 wt % Nb alloys annealed from a single β phase and heated to >600°C. Addition of oxygen to the alloy considerably increased its superconducting properties. (R.V.J.)

29395 EXCITATIONS IN A PURE TYPE-II SUPERCONDUCTOR. Chowdhury, S. M. M. R.; Das, A. K. (Atomic Energy Centre, Dacca, Pakistan). Phys. Lett., 26A: 565-6(Apr. 22, 1968).

With a specific model for the spatially varying gap parameter, the Bogolyubov equations are solved for low magnetic field ($H \ll H_{c2}$). (auth)

29396 FORMATION OF CHARGED VORTEX RINGS IN LIQUID HELIUM BELOW 0.8°K. Cunsolo, S.; Maraviglia, B.; Ricci, M. V. (Univ., Rome). Phys. Lett., 26A: 605-6(May 6, 1968).

Two different thresholds and a constant drift velocity for creation of negatively charged vortex rings are shown to exist. (auth)

29397 FREQUENCY AND TIME-DOMAIN ANALYSIS OF A SUPERCONDUCTIVE COAXIAL LINE USING THE TWO-FLUID MODEL. McCaa, W. D. Jr.; Nahman, N. S. (National Bureau of Standards, Boulder, Colo.). J. Appl. Phys., 39: 2592-6(May 1968).

From Applied Superconductivity Conference and Exhibition, Austin, Tex. See CONF-671116.

A miniature 80-ft superconductive coaxial line (Nb inner conductor 0.01 in. o.d., Pb outer conductor 0.034 in. i.d., polytetrafluoroethylene dielectric) has been analyzed in terms of the Gorter-Casimir two-fluid superconductivity model, considering the anomalous and classical cases (without relaxation effects) for the normal components. The dielectric and the metal flux trapping losses are assumed to be negligible. The 10^6 to 10^{12} Hz line attenuation and the 1 to 100 psec step responses are presented for the temperature range of 2.3 to 10°K. Predictions are compared with the experimental results of several independent investigators. It is concluded that if the dielectric and the metal flux-trapping losses are negligible, then (1) The model provides bounds between which the responses of physically realized lines will fall, and (2) The normal conductivity of the conductors must be very good if the maximum bandwidth and minimum risetime are to be obtained. (auth)

29398 FREQUENCY CONVERSION USING WEAK MULTIPLY CONNECTED JOSEPHSON JUNCTIONS. Rothwarf, F.; Krisch, H. M.; Ford, D. (Frankford Arsenal, Philadelphia). J. Appl. Phys., 39: 2683-5(May 1968).

From Applied Superconductivity Conference and Exhibition, Austin, Tex. See CONF-671116.

A Josephson tunneling device essentially consisting of a lead–tin solder bead encircling a 5-mil niobium wire has been used to produce some frequency conversion effects. Thin spots in the oxide of the niobium wire give rise to two or more parallel weak-contact regions between the solder and the niobium. A typical voltage vs junction current plot displays an antisymmetric tunneling curve with zero voltage across the junction until a certain current I_{jc} is supplied. A field current I_H flowing through the niobium wire produces a magnetic flux which links the multiply connected region(s) formed by the penetration depths of the solder and the niobium and the distance(s) between the parallel weak contacts. The critical current I_{jc} is a periodic function of the magnetic flux threading the multiply connected region(s), the modulation period being proportional to one flux quantum. When the device is biased with a junction current I_j in the interval $I_{jc} \leq I_j \leq 3I_{jc}$, a modulated dc voltage appears across the junction as I_H is varied. The period of the oscillations is independent of the junction bias I_j. The number of cycles ΔN produced for a given absolute change $|\Delta I_H|$ defines the junction constant K_j of the device. K_j depends upon the geometry of the device and the penetration depths of the superconductors used in its construction. If a time varying I_H is applied to the niobium wire an output frequency f_0 can be obtained, given by the relation $f_0 = K_j|dI_H/dt|$. For a triangular I_H the device acts as a frequency multiplier giving $f_0 = 4K_j I_{Hm} f_{in}$, where I_{Hm} is the current amplitude of the triangular waveform and f_{in} its frequency. A sinusoidal I_H gives rise to a frequency-modulated output: $f_0 = 2\pi K_j I_{Hm} f_{in} |\cos 2\pi f_{in} t|$. Other input waveforms yield other frequency-modulated outputs. (auth)

29399 GRAVITATION-INDUCED HALL EFFECT IN TYPE-I SUPERCONDUCTORS. Papini, G. (Univ. of Saskatchewan Regina Campus). Phys. Lett., 26A: 589-90(May 6, 1968).

A gravitationally induced time-independent Schiff–Barnhill field can give rise to a Hall effect in type-I superconductors. The case of a rotating superconducting slab is considered in particular. (auth)

29400 HIGH-FIELD SUPERCONDUCTING MAGNET. Wurz, W. (Bell Telephone Lab., Inc., Whippany, N. J.). J. Appl. Phys., 39: 2628-32(May 1968).

From Applied Superconductivity Conference and Exhibition, Austin, Tex. See CONF-671116.

A large superconducting magnet has been built which makes it possible to maintain magnetic fields of up to 20 kG for several hours within a horizontal room-temperature work space of 10 cm diameter. The i.d. of the superconducting coil is 16.5 cm. High stability of the magnetic field has been achieved by winding laminated sheets, half-copper, half-stainless steel, between the layers of the coil. The current density is about 20,000 A/cm^2. Access to the superconducting coil is provided by a new cryogenic seal, which makes the exchange and rearrangement of the coils possible, and, consequently, permits different field shapes. (auth)

29401 HIGH-RESOLUTION MAGNETO-OPTICAL OBSERVATION OF MAGNETIC STRUCTURES IN SUPERCONDUCTORS. Kirchner, H. (Forschungslaboratorium der Siemens AG, Munich). Phys. Lett., 26A: 651-2(May 6, 1968).

High resolution of magnetic structures in superconductors is obtained by means of the Faraday effect applying thin evaporated EuS/EuF_2 films of high specific Faraday rotation. Preliminary experimental results indicate a resolution of at least 2 μm. (auth)

29402 INTERACTION OF ELECTRONS WITH PARAMAGNETIC IMPURITIES IN SUPERCONDUCTORS. Ginzburg, S. L. (Ioffe Inst. of Physics and Tech., Leningrad). JETP Lett., (USSR) (Engl. Transl.), 7: 72-4(1968).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 7: 96-8(Feb. 5, 1968).

The problem of the scattering of an electron in a superconductor by a paramagnetic impurity is solved by a dispersion method that employs the unitarity relations and the analytic properties of the scattering amplitude. An expression is derived for the scattering amplitudes for the particular case of unity spin and zero nonexchange part of the interaction. With the aid of this expression it is possible to calculate the temperature of the transition into the superconducting state and the gap at zero temperature for a superconductor with a low density of paramagnetic impurities. (A.G.W.)

29403 λ-POINT ANOMALY IN ROTATING HELIUM. Pellam, John R. (Univ. of California, Irvine). Phys. Rev. Lett., 20: 1144-6(May 20, 1968).

New experiments on the nature of rotating liquid helium II using a Rayleigh disk probe qualitatively substantiate earlier results by the author, which showed a marked temperature anomaly in the region just below the λ point. The method used in the new experiments was based on achieving rotational equilibrium of the disk system under conditions of total darkness and then recording the associated disk deflections by means of flash photographs. The results are believed to eliminate the explanation proposed by Tsakadze and Shanshiashvili that the anomaly was due to thermal effects introduced by the optical system used for observing the disk behavior. (A.G.W.)

29404 LINEARITY OF THE VOLTAGE–CURRENT CHARACTERISTIC OF A TYPE-II SUPERCONDUCTOR. Chang, C. C.; Rose-Innes, A. C. (Univ. of Manchester, Eng.). Phys. Lett., 26A: 634-5(May 6, 1968).

Experiments on a very uniform specimen of type-II superconductor indicate that, at all currents above the critical current, there is an inherently linear relation between the voltage and current. (auth)

29405 LIQUID HELIUM AND THE PROPERTIES OF A BOSE–EINSTEIN GAS. I. A NUMERICAL STUDY OF HARD-CORE MODELS. Goble, D. F.; Trainor, L. E. H. (Univ. of Toronto). Can. J. Phys., 46: 839-54(Apr. 1, 1968).

The properties of a hard-sphere, Bose–Einstein gas are investigated numerically in the t-matrix, ladder approximation, using both the coordinate-space treatment of Brueckner and Sawada, as

modified by Parry and ter Haar, and the pseudopotential method of Liu and Wong. For each treatment, the form of the excitation spectrum and the thermodynamic properties of the gas at low temperatures are compared with the corresponding properties of liquid helium. The pseudopotential method gives better agreement for a reasonable choice of the radius of the hard-core interaction. This result is not surprising since the actual potential corresponding to the pseudopotential of Liu and Wong is intermediate between the soft-core potential of Brueckner and Sawada and a true hard-core potential. (auth)

29406 MEASUREMENT OF THE PRESSURE AMPLITUDE IN A SECOND SOUND WAVE. Hofmann, A.; Keck, K.; Schubert, G. U. (Univ., Mainz). Phys. Lett., 26A: 598-9(May 6, 1968).

First and second sound are radiated from a periodically heated carbon layer. The pressure amplitudes of the first sound and of the second sound have been measured using a sensitive condenser microphone. (auth)

29407 MEASUREMENTS OF ULTRASONIC ATTENUATION IN NIOBIUM NEAR H_{c2}. Forgan, E. M.; Gough, C. E. (Univ. of Birmingham, Eng.). Phys. Lett., 26A: 602-3(May 6, 1968).

Measurements of ultrasonic attenuation in the mixed state of several niobium single crystals reveal a purity dependence which is in disagreement with a recent theory due to Maki. (auth)

29408 MILLIMETER-WAVE MIXING WITH JOSEPHSON JUNCTIONS. Grimes, C. C.; Shapiro, Sidney (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., 169: 397-406(May 10, 1968).

Experiments are reported in which two millimeter-wave signals incident on point-contact Josephson junctions produced changes in the junction dc voltage versus current characteristic and an intermediate frequency output whose amplitude depended sensitively on both junction bias and applied power. Equations are derived, based on Josephson's phenomenological equations, for the Josephson current in a junction exposed to two applied rf signals. When the applied signals differ appreciably in frequency, additional constant-voltage steps in the V–I curve are predicted, which are spaced at the difference frequency. These steps have been observed in experiments employing sources at 64 and 72 Gc/sec. Results of mixing experiments utilizing two sources nearly equal in frequency are reported at 23 and at 72 Gc/sec. In this case the two waves beat together and are equivalent in their effect to a single signal amplitude modulated at the difference frequency. Also explained on the same basis are experiments in which the third harmonic of a signal at 24 Gc/sec mixed with a signal at 72 Gc/sec. These results demonstrate the existence of the Josephson mixing mechanism as opposed to classical nonlinear mixing, and they show that it is operative at microwave and millimeter-wave frequencies over a wide range of power. (auth)

29409 NARROW TAIL GLASS HELIUM DEWAR. Frindt, R. F.; Stuart, A. (Simon Fraser Univ., Burnaby, British Columbia). Rev. Sci. Instrum., 39: 782(May 1968).

A single glass helium Dewar which has a conduction–cooled metallic radiation shield around the tail of the helium container is described. This provides for a large working space in the tail of the helium container. An optical Dewar and a Dewar used in NMR experiments are discussed. (W.H.K.)

29410 NONMAGNETIC LOCALIZED IMPURITY STATES IN DILUTE SUPERCONDUCTING ALLOYS. Upadhyaya, U. N.; Sinha, K. P. (National Chemical Lab., Poona, India). Phys. Rev., 169: 395-7(May 10, 1968).

The effect of magnetic-element impurities in a virtual nonmagnetic state on the superconducting transition temperature T_c of dilute alloys is discussed. It is found that, in general, one-body-type interactions between conduction (s) electrons of the host metal and the d electrons of the impurity atoms tend to decrease T_c, whereas the two-body type of interactions between s and d electrons can enhance T_c under certain conditions. It appears that the additional attractive electronic interaction, in contradistinction to the phonon-induced mechanism, between electrons of the BCS pairs is a consequence of a proper cognizance of the instantaneous two-body interaction between conduction and impurity electrons. (auth)

29411 OCCURRENCE AND ORIGIN OF FLUX JUMPS IN HARD SUPERCONDUCTING CYLINDERS. Morton, N. (General Electric Co. Ltd., Wembley, Eng.). Cryogenics, 8: 79-81 (Apr. 1968).

Measurements were made of the flux jumps occurring during the magnetization at various rates of tubes of hard superconductors immersed in liquid helium at 4.2°K. The rate dependence and magnitudes of the flux jumps are explained semi-quantitatively assuming that small, critical, spatial temperature fluctuations are responsible for the instabilities. (auth) (UK)

29412 ON THE ANOMALOUS DISPERSION IN SECOND SOUND OF LIQUID HE II. Ichiyanagi, Masakazu (Osaka Univ.). Progr. Theor. Phys. (Kyoto), 39: 541-3(Feb. 1968).

A brief theoretical derivation of the anomalous second sound dispersion of liquid helium II is presented. (M.O.W.)

29413 OPTIMUM DESIGN OF SUPERCONDUCTING SOLENOIDS AND SUPERCONDUCTING PERMANENT MAGNETS WITH FERROMAGNETIC POLE PIECES. Lange, F. (Institut fuer Tieftemperaturphysik, Dresden). Cryogenics, 8: 103-4(Apr. 1968).

The addition of ionically tapered, ferromagnetic pole pieces to a superconducting solenoid or superconducting permanent magnet means that very high constant magnetic fields are obtainable in small volumes. Calculations are presented and optimum dimensions deduced. (auth)

29414 OPTICAL OBSERVATION OF LOSSES IN A SUPERCONDUCTOR IMMERSED IN LIQUID HELIUM. Colombeau, M.; Le Tiran, E.; Mailfert, A. (Laboratoire Central des Industries Electriques, Fontenay-aux-Roses, France). Rev. Phys. Appl., Suppl. J. Phys., 3: 18-20(May 1968). (In French).

An optical method is proposed by which small temperature differences between a superconducting sample fed with an ac current, and the liquid helium bath surrounding it may be observed. (auth)

29415 PERFORMANCE OF SUPERCONDUCTING OSCILLATORS AND FILTERS. Stone, J. L.; Hartwig, W. H. (Univ. of Texas, Austin). J. Appl. Phys., 39: 2665-71(May 1968).

From Applied Superconductivity Conference and Exhibition, Austin, Tex. See CONF-671116.

With improved understanding of loss mechanisms in superconducting resonant circuits (SRC), it is possible to design a variety of devices which take advantage of the high Q. Superconducting surface resistance, trapped-flux loss, and residual losses which are annealable can all be related to the superconductor itself. Dielectric dissipation is well enough understood to permit this source of loss to be minimized. Coupling and radiation losses can be made negligible. SRC's are described with a variety of geometries to fill the range from 10 MHz to 10 GHz. Type-I superconductors provide the highest Q's and are readily fabricated by several techniques. The superconducting resonator can be tuned accurately in frequency by temperature control of the surface reactance as well as the dielectric constant of liquid helium. An external magnetic field can be used to tune the bandwidth as well as the resonant frequency. A quarter-wave reentrant cavity is ideally suited for use as an optically tuned frequency-control element. This is accomplished using the photodielectric effect in high-resistivity semiconductor wafers which terminate the stub. Wide-bandwidth optical communication detectors are described using semiconductors with short recombination lifetime. Oscillators have been built which are optically tuned, and others which have frequency stabilities as good as commercial frequency counters. Use of SRC's to study material properties at low temperature is emphasized. (auth)

29416 PHOTODIELECTRIC DETECTOR USING A SUPERCONDUCTING CAVITY. Arndt, G. D.; Hartwig, W. H.; Stone, J. L. (Univ. of Texas, Austin). J. Appl. Phys., 39: 2653-6 (May 1968).

From Applied Superconductivity Conference and Exhibition, Austin, Tex. See CONF-671116.

Photoinduced free-carrier processes in Si and Ge have been studied in superconducting cavities to exploit their excellent frequency stability and negligible dissipation. Using the narrow bandwidth and very high unloaded Q, it is possible to detect changes in the complex dielectric constant by observing the shift in resonant frequency. Simultaneous measurement of relative power absorption gives additional and confirming data. An increase in frequency of several kHz/mW and a linear power absorption are observed for low values of light. At higher intensity both responses become nonlinear due to the growth of the plasma frequency and nonuniform carrier density distribution. For a 525 Ω-cm sample of n-type Si in a cavity with resonances at 290 and 810 MHz, data analysis showed the thermal carrier density at 4.2°K was 10^9 cm^{-3}, relaxation time was 1.44×10^{-10} sec, the Fermi level was 0.00305 eV above the donor level, and the unilluminated plasma frequency was 148 MHz. The product of conversion efficiency and free-carrier lifetime was approximately 10^{-10} sec, indicating the effect could be used for a wide-bandwidth optical detector. By repeating the experiment at different frequencies, temperatures, and wavelengths, the theoretical agreement holds and considerable insight can be gotten into recombination and trapping processes, lattice collision and mobility effects, and the changes in these phenomena with radiation and stress of many kinds. (auth)

29417 POSSIBLE COMPETING SUPERCONDUCTING AND INSULATING MECHANISMS IN SEMICONDUCTORS AND SEMIMETALS. Wong, K. W.; Bajaj, K. K. (Univ. of Kansas, Lawrence). Phys. Lett., 26A: 521-2(Apr. 22, 1968).

Superconducting and excitonic insulating phase transitions in semimetals and semiconductors are studied. It is suggested that in some materials with a many-valley-type band structure, excitonic insulating transition may compete with the superconducting transition and therefore these materials may exhibit a kind of "mixed" transition. A few materials are proposed which may show either the excitonic insulating or the mixed transition at low temperature and under pressure. (auth)

29418 PROBLEMS IN DESIGNING NONAXISYMMETRICAL SUPERCONDUCTING MAGNET SYSTEMS. Gauster, W. F.; Coffey, D. L. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. J. Appl. Phys., 39: 2647-51(May 1968). (ORNL-P-3587).

From Applied Superconductivity Conference and Exhibition, Austin, Tex. See CONF-671116.

At the Oak Ridge National Laboratory a large superconducting B_{min} facility "IMP" (Injection into Microwave Plasma) is under construction. In order to build this system in an economical way, optimization methods for designing nonaxisymmetrical magnet systems have been developed. A discussion of these new design methods and of a series of unusual technological tests (for instance, experiments with superconducting test coils in cusp arrangement, exposed to external magnetic fields) is of general importance for the design of nonaxisymmetrical superconducting magnet systems. (auth)

29419 PROPOSED AMMETER USING FLUX QUANTIZATION. Meservey, R. (Massachusetts Inst. of Tech., Cambridge). J. Appl. Phys., 39: 2598-2605(May 1968).

From Applied Superconductivity Conference and Exhibition, Austin, Tex. See CONF-671116.

The possibility is discussed of using flux quantization in superconductors as the basis of an ammeter and more generally as a fundamental standard of electromagnetic measurement. A particular design is proposed and in this context some of the fundamental design problems of this sort of instrument are considered. It is concluded that an instrument of this type could measure a current in terms of the flux quantum, length, and time to an accuracy approaching 1 part in 10^8. The limitations and advantages of the proposed instrument are discussed and comparisons are made with present current-measuring instruments and some conjectures are made of the future potential of flux quantization instruments of this kind. (auth)

29420 RADIANT-ENERGY DETECTION BY SUPERCONDUCTING FILMS. Bertin, C. L.; Rose, K. (Rensselaer Polytechnic Inst., Troy, N. Y.). J. Appl. Phys., 39: 2561-8(May 1968).

From Applied Superconductivity Conference and Exhibition, Austin, Tex. See CONF-671116.

Superconducting films offer promise as fast, sensitive detectors at intermediate frequencies from millimeter waves to near infrared. The superconductor's marked temperature dependence of resistance about its transition temperature suggests that it would have a high responsivity as a bolometer, and operation at cryogenic temperatures suggests that a low NEP can be achieved. In addition, placing the sample in the liquid-helium bath should result in very short response times (τ) on the order of 10 nsec. Films have been studied with sheet resistances from 200 Ω/sq to >1000 Ω/sq. These films achieve NEP $\approx 10^{-9}$ W · Hz$^{-\frac{1}{2}}$ as bolometers with $\tau \approx 20$ nsec. There is an enhanced microwave response, NEP $\approx 10^{-11}$ W · Hz$^{-\frac{1}{2}}$ with $\tau = 20$ nsec, which is especially pronounced for high-resistance films. This mode shows promise for use in the far-infrared and submillimeter region. The bolometer mode compares favorably with other bolometers. (auth)

29421 RELAXATION OF THE SUPERCONDUCTING ORDER PARAMETER. Woo, James W. F.; Abrahams, Elihu (Rutgers-The State Univ., New Brunswick, N. J.). Phys. Rev., 169: 407-13(May 10, 1968).

The nonequilibrium behavior of a pure type-I superconductor is investigated and the effects of the electron-phonon interaction are taken into account. The formulation is based on Kadanoff-Baym transport equations suitably generalized to the case of superconductors. In order to investigate the relaxation behavior of the order parameter due to real phonon transitions, the transport equations are solved in the spatially homogeneous case when there is a slow time variation of the energy-gap function. In solving the transport equations the real phonon transitions are treated in the weakest possible way, much in the spirit of the Bardeen–Rickayzen–Tewordt (BRT) transport equation used in the treatment of thermal conductivity. Reasons for the failure of the BRT equation in this case, and in general when there is a time variation of the order parameter are discussed. For weak-coupling materials, it is found that for $0.09 \leq T/T_c \leq 0.99$, the gap relaxation rate (10^8 to 10^9 sec^{-1}) is about an order of magnitude slower than the quasiparticle decay rate, but that very close to T_c it disappears as $T \to T_c$. (auth)

29422 RESISTIVE STATES IN HIGH-FIELD TYPE-II SUPERCONDUCTORS. Maki, Kazumi (IBM Zurich Research Lab., Switzerland). Phys. Rev., 169: 381-7(May 10, 1968).

In the high-field region, the longitudinal electrical current and the transverse heat current in the resistive states of high-field type-II superconductors (i.e., type-II superconductors with a large Pauli paramagnetism) are calculated. It is suggested that measurements of the longitudinal resistivity together with magnetization data allow one to decompose the magnetization into components due to diamagnetic and paramagnetic currents. (auth)

29423 RESULTS OF TESTS ON MODELS FOR AN 88-kG, 51-cm-BORE-DIAMETER SOLENOID. Stekly, Z. J. J. (Avco-Everett Research Lab., Everett, Mass.); Lucas, E. J.; de Winter, T.; Strauss, B.; Di Salvo, F.; Laurence, J.; Coles, W. J. Appl. Phys., 39: 2641-6(May 1968).

From Applied Superconductivity Conference and Exhibition, Austin, Tex. See CONF-671116.

As part of a program to build an 88 kG, 51-cm-bore solenoid, two model coils were built to test the conductor characteristics as well as the final coil-construction techniques. The first coil was wound with a square conductor 0.218 cm on a side, with many strands of Nb–Ti. The coil winding i.d. was 15.24 cm, the o.d. was 22.3 cm, and the length was 10.16 cm. This coil was built using small cooling passages, and its construction was such as to simulate the techniques to be used up to 80 kG in the full-size magnet. The second coil was wound with steel reinforced Nb_3Sn of over-all dimensions 1.27 cm by 0.0292 cm and had a winding i.d. of 12.2 cm and an o.d. of 31.1 cm, and consisted of two pancakes. Its purpose was to simulate the high-field windings of the full-size coil. Both coils were instrumented with heaters to determine their stability characteristics. The performance of each coil is discussed with regard to stability, charge rate, and quench characteristics. (auth)

29424 SHIFT OF λ POINT OF LIQUID HELIUM IN A ROTATING ANNULAR GAP. Dzhinchvelashvili, B. G.; Tsakadze, Dzh. S. (Inst. of Physics, Tbilisi, USSR). JETP Lett. (USSR) (Engl. Transl.), 7: 68-9(Feb. 5, 1968).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 7: 91-2 (Feb. 5, 1968).

It has been shown previously that the λ point of liquid helium in a rotating singly connected loop experiences no shift, accurate to 5×10^{-4} degrees, at a rotation speed $\omega_0 = 0.56$ sec^{-1}. Here, the measurement accuracy was increased by more than one order of magnitude, on the one side, and higher rotation speeds were used, on the other. A resistance thermometer made of lead–brass wire bifilarly wound on a paper ribbon was used. Helium II near the λ point was set in rotation, after which the vacuum pump was disconnected and the rotating He II was converted into He I, and at the same time a thermogram of the heating of the liquid was plotted; the λ-point position was clearly seen on the plot in the form of a characteristic break. (M.H.R.)

29425 SENSITIVE MAGNETOMETER BASED ON SUPERCONDUCTIVITY. Radhakrishna, P.; Nielsen, M. (Danish Atomic Energy Commission Research Establishment, Risoe). Cryogenics, 8: 106-7(Apr. 1968).

The operation of the magnetometer described is based on the property of zero resistance in a superconducting loop, resulting in the conservation of magnetic flux. The magnetometer circuit consists of three solenoids of superconducting wire, one surrounding the sample under investigation, one surrounded by a concentric copper coil, and the third wound about a magnetic field probe. A change of flux in the first solenoid, due to the sample, induces a persistent current in the closed circuit. This may be reduced to zero by passing a compensating current through the copper coil around the second solenoid, the point of balance being sensed by the field probe in the third solenoid. The current in the copper coil is then a measure of the initial flux change. (auth) (UK)

29426 SOUND IN LIQUID HE II. Ichiyanagi, Masakazu (Osaka Univ.). Progr. Theor. Phys. (Kyoto), 39: 543-4(Feb. 1968).

Mori's theory is applied to liquid helium II, and then the nature of sound waves is briefly discussed. (M.O.W.)

29427 SUPERCONDUCTING INTERACTIONS IN TIN TELLURIDE. Hulm, J. K. (Westinghouse Research Labs., Pittsburgh); Jones, C. K.; Deis, D. W.; Fairbank, H. A.; Lawless, P. A. Phys. Rev., 169: 388-94(May 10, 1968).

The range of superconductivity in tin telluride has been extended down to 4×10^{20} carriers per cc. Experimentally there is no indication of a cutoff in superconductivity, although the data are not inconsistent with the theoretically indicated cutoff at 4×10^{19} carriers per cm^3. By using a modified form of the Morel–Anderson theory in conjunction with a modified BCS equation due to McMillan, it is possible to fit the experimental data and to find the magnitude of the umklapp contribution to the attractive phonon interaction. The resulting values are approximately a factor of 10 smaller than the values predicted by the Morel–Anderson theory. (auth)

29428 SUPERCONDUCTING PROPERTIES OF REACTIVELY SPUTTERED THIN-FILM TERNARY NITRIDES, Nb–Ti–N AND Nb–Zr–N. Bell, H.; Shy, Y. M.; Anderson, D. E.; Toth, L. E. (Univ. of Minnesota, Minneapolis). J. Appl. Phys., 39: 2797-2803(May 1968).

Superconducting critical fields, currents, and temperatures of reactively sputtered thin films of Nb–Ti–N and Nb–Zr–N ternary alloys have been determined as a function of composition, and these properties are compared with those of sintered bulk nitrides of the same composition. The thin films have substantially higher critical current densities, higher critical fields, but lower critical temperatures than the bulk samples. In fields as high as 136 kOe, the J_c characteristics of the nitride films compare favorably with the thin-film characteristics of Nb_3Sn and V_3Si. The J_c–H properties of the nitride films are relatively insensitive to the Nb : Ti(Nb : Zr) ratio, a characteristic which favors these materials for certain practical applications such as thin-film solenoids. An unusual temperature independence of the electrical resistance was found for several compositions. (auth)

29429 SUPERCONDUCTIVITY IN NIOBIUM AND NIOBIUM-RICH NIOBIUM–TANTALUM ALLOYS. Ikushima, A.; Mizusaki, T.; Odaka, T. (Osaka Univ.). Phys. Lett., 26A: 582-3(May 6, 1968).

Magnetization measurements in superconducting Nb and Nb-rich Nb–Ta alloys show that the discrepancies between experiment and theory in κ_1 and κ_2 as function of temperature in Nb do not come from its nonweak coupling nature but probably from the anisotropic electronic structure. (auth)

29430 SUPERCONDUCTORS WITH MAGNETIC IMPURITIES IN AN APPLIED MAGNETIC FIELD. Cyrot, M. (Faculte des Sciences, Orsay, France). J. Phys. Chem. Solids, 29: 663-75 (1968).

The nature of the transition in superconducting alloys with magnetic impurities under an applied magnetic field is discussed. It is shown that a first-order transition can occur. The upper critical field is calculated as a function of temperature. Non-monotonic functions of temperature are obtained under certain conditions, which are discussed. Finally, the effect of spin–orbit coupling is considered. (auth) (UK)

29431 TEMPERATURE AND MEAN-FREE-PATH DEPENDENCE OF THE UPPER CRITICAL FIELD IN INDIUM–LEAD ALLOYS. Zoller, Paul; Dillinger, J. R. (Univ. of Wisconsin, Madison). Phys. Rev. Lett., 20: 1154-5(May 20, 1968).

Measurements of the specific heat of In–Pb alloys of varying lead concentration were used to deduce the temperature and mean-free-path dependence of Maki's parameter κ_1. The most impure sample showed the strongest temperature dependence of κ_1 in complete disagreement with existing theories. (auth)

29432 TESTS ON THE MAINTENANCE UNDER ORBITAL FLIGHT CONDITIONS OF LOW TEMPERATURE ASSURING THE OPERATION OF SUPERCONDUCTING SYSTEMS. Anashkin, O. P.; Belitskii, B. M.; Brodskii, V. B.; Kurnosova, L. V.; Mikhailov, N. N.; Razorenov, L. A.; Sidyakina, T. M.; Fradkin, M. I. Kosm. Issled., 6: 132-43(Jan.–Feb. 1968). (In Russian).

The results of experiments on the verification of the possibility of the operation of superconducting devices on board space vessels are reported. Helium at pressure of 2.4 atm (initial temperature ~5.2°K) was used as coolant. In flight the temperature at six points of the helium container, the pressure in the container, and the voltage of the magnetic field in two short-circuited superconducting solenoids were controlled. As a result of the measurement it was established that such a method for the control of the low temperature can be successfully used under weightless conditions. (tr-auth)

29433 THE THERMAL CONDUCTIVITY OF TYPE-II SUPERCONDUCTORS: In–Pb ALLOYS. II. COMPARISON WITH THE CAROLI–CYROT THEORY. Muto, Yoshio; Noto, Koshichi; Mamiya, Takayoshi; Fukuroi, Tadao (Tohoku Univ., Sendai). J. Phys. Soc. Jap., 24: 992-5(May 1968).

From the standpoint of the Caroli and Cyrot theory, the thermal conductivity near the upper critical field of indium–lead alloys are investigated. The agreement between the experiment and the theory is found sufficient for every specimen at all temperatures under study. (auth)

29434 THEORY OF OPTICAL PROPERTIES OF AN EXCESS ELECTRON IN LIQUID HELIUM. Duvall, B.; Celli, V. (Univ. of Virginia, Charlottesville). Phys. Lett., 26A: 524-5(Apr. 22, 1968).

The excitation energies and cross sections for optical transitions of an excess electron in liquid ^4He have been computed. The Raman cross section is found to be about 10^{-29} cm^2, in disagreement with other estimates. (auth)

29435 THE TRANSIENT STABILIZATION OF Nb_3Sn COMPOSITE RIBBON MAGNETS. Hale, J. R.; Williams, J. E. C. (Massachusetts Inst. of Tech., Cambridge). J. Appl. Phys., 39: 2634-8(May 1968).

From Applied Superconductivity Conference and Exhibition, Austin, Tex. See CONF-671116.

The transient thermal behavior of a section of composite superconducting ribbon which has suffered a sudden rise in temperature has been investigated in detail by computer simulation. Three equations describing a one-dimensional flow of heat from the composite, through an insulating film and the subsequent diffusion of heat into a metal foil, have been programmed for simultaneous numerical solution. The effectiveness of the interleaving in stabilizing the composite has been found to depend strongly on the thermal conductivity and thickness of the insulating film, as well as the thermal properties of the metal foil. Also, values of the initial sudden temperature rise due to a collapse of magnetization have been calculated. Estimations, based on the numerical results, are made of the effectiveness of various interleaving materials. (auth)

29436 TUNNELING EFFECT BETWEEN TWO-ZONE SUPERCONDUCTORS WITH NONMAGNETIC IMPURITIES. Golub, A. A.; Moskalenko, V. A. (Inst. of Mathematics With Computing Center, Kishinev, USSR). Fiz. Metal. Metalloved., 25: 385-9(Mar. 1968). (In Russian).

Two-zone superconductors with nonmagnetic impurities were investigated, and the tunnel current appearing during the tunneling transition was studied as a function of the concentration of impurities. (R.V.J.)

29437 VACANCIES AND SUPERCONDUCTIVITY IN TITANIUM MONOXIDE. Doyle, N. J.; Hulm, J. K.; Jones, C. K.; Miller, R. C.; Taylor, A. (Westinghouse Research Labs., Pittsburgh). Phys. Lett., 26A: 604-5(May 6, 1968).

The superconducting transition temperature of stoichiometric titanium monoxide has been found to be strongly dependent upon the concentration of lattice vacancies. (auth)

29438 AN INTRODUCTION TO THE THEORY OF SUPERCONDUCTIVITY. Kuper, C. G. Oxford, Clarendon Press, 1968. 294p. 60s.

The subject is treated under the following headings: phenomenological theory (macroscopic electrodynamic properties of superconductors, two-fluid models, the London electrodynamic equations, superconducting electrodynamics in Fourier space, surface energy at a normal superconducting interface, spatial inhomogeneity of the order parameter-improved phenomenological theories, type-II superconductivity, tunnelling); microscopic theory (second quantisation, Bloch–Froehlich electron-phonon interaction, superconducting ground state, quasiparticles, electromagnetic properties of superconductors, the Gor'kov method-propagators in superconductors, criteria for superconductivity). (UK)

29439 CRITICAL MAGNETIC FIELDS OF SUPERCONDUCTING TUNGSTEN. Black, William Carter Jr. Urbana, Ill., Univ. of Illinois, 1967. 171p.

Thesis.

The thermodynamic critical field curve of a superconducting tungsten specimen with resistivity ratio 7,500 has been measured as a function of temperature down to 3 m°K (1 m°K $\equiv 10^{-3}$°K). From the raw data the critical field H_0 at T = 0 is found to be 1.141 ± .007 G, and the zero field transition temperature T_c is 15.39 ± .17 m°K. The normal-state electronic specific heat parameter γ, as derived from the critical field data, is 0.87 ± .04 mJ/mole °K^2. However, the magnetic field at the specimen is slightly altered by the nearby paramagnetic refrigerant thermometer. An estimated correction applied to the data gives the new values H_0 = 1.148 ± .010 G, T_c = 15.37 ± .17 m °K, and γ =

0.90 ± .06 mJ/mole °K², which are considered to be the most probable values of these parameters for the tungsten specimen. Deviation of the measured critical field from a parabolic dependence on temperature is in good agreement with the weak-coupling BCS theory. The very small calculated Ginzburg–Landau parameter ($\varkappa \simeq 2 \times 10^{-3}$) and extremely large calculated coherence length ($\xi_0 \simeq 32\mu$) are favorable for observation of a large supercooling effect in tungsten at temperatures well below T_c. Assuming that the ideal critical supercooling field was observed on an electropolished specimen, the experimental value for $\varkappa$ is $(2.6 \pm 1.6) \times 10^{-3}$. A large and reproducible, though less than ideal, superheating effect was also observed with this same electropolished specimen. (Diss. Abstr.)

29440 THERMAL CONDUCTIVITY OF SUPERCONDUCTING TIN FILMS IN A MAGNETIC FIELD. Smith, John Ernest Jr. Urbana, Ill., Univ. of Illinois, 1967. 105p.

Thesis.

The magnetic field dependence of the thermal conductivity of superconducting tin films was measured in a parallel field ranging from zero to above the critical fields, and at temperatures from 0.3 to 1°K. They had electron mean free paths l which were from 18% to 85% of the bulk coherence length ξ_0. The Landau–Ginzburg parameter $\varkappa$ was sufficiently enhanced by the effect of the short mean free paths that in our thicker films it was possible to observe the surface sheath region of de Gennes and Saint James. An expression was derived for the field dependence of the thermal conductivity in this region, based upon theoretical calculations of Caroli and Cyrot and of Maki; this expression, which is strictly valid only in the limit $l/\xi_0 \to 0$, is in good agreement with the experimental results. The experimental results for thinner films were compared with theoretical calculations of the field dependence of the thermal conductivity by Maki. These expressions are also restricted in validity to the limit $l/\xi_0 \to 0$. Here the agreement between the theory and the data is not so good as in the thick film case, but it improves as the experimental values of l approach the limit $l/\xi_0 \to 0$. (Diss. Abstr.)

29441 ULTRASONIC ATTENUATION IN SUPERCONDUCTING MERCURY AND MERCURY–CADMIUM ALLOYS. Newcomb, Charles Preston. Troy, N. Y., Rensselaer Polytechnic Inst., 1967. 107p.

Thesis.

The attenuation of longitudinal ultrasound in superconducting mercury was measured using the pulse-echo technique. The samples were single crystals of pure (99.99999%) mercury with the sound propagating along the two- and three-fold axes, a pure polycrystal, and two-fold single crystals doped with from .01 to .1 wt % cadmium. The attenuation was studied in the frequency range of 10 to 130 MHz. The main purpose of the work was the systematic study of the distinctly non-BCS-like behavior of mercury as a function of cadmium doping concentration, frequency and propagation direction. The behavior was not in agreement with the BCS theory of superconductivity in that the attenuation in the superconducting state decreased much too rapidly near T_c. The rapidity of the drop increased with increasing sound frequency and decreased with increasing cadmium concentration. The data were systematized by the use of a model wherein the behavior is explained by multiple, anisotropic superconducting energy gaps — one for each of the two sheets of the mercury Fermi surface. Both the large anisotropies ($2\Delta(0)$ ranging from $2kT_c$ to $7kT_c$) needed to explain the data in this way and the inability to explain the three-fold data lead to the conclusion that the anomalous behavior is not due to these mechanisms alone. Evidence is also presented that it is probably not due to a temperature-dependent dislocation background attenuation either. It is concluded that more theoretical work and more experimental work where the data are analyzed in such a way as to present quantitative information near T_c are needed. In addition, an informal measurement of the velocities lead to values of the elastic constants c_{11} and c_{33} which deviate considerably from previously published values. (Diss. Abstr.)

29442 SPECIAL SECTION ON APPLIED SUPERCONDUCTIVITY. CONFERENCE HELD IN AUSTIN, TEXAS ON 6–8 NOVEMBER 1967. J. Appl. Phys., 39: 2489-2686(May 1968). (CONF-671116).

Special abstracts were prepared for 32 of the included 33 articles. The remaining paper appeared previously in NSA as 22: 2966. Abstracts only are included for the other papers presented at the conference. (M.O.W.)

For abstracts of individual papers see: 28173, 28443, 29386–29389, 29392, 29397, 29398, 29400, 29415, 29416, 29418–29420, 29423, 29435, and 29444–29458.

29443 DEVICE APPLICATIONS OF SUPERCONDUCTIVE TUNNELING. Taylor, B. N. (Radio Corp. of America, Princeton, N. J.). J. Appl. Phys., 39: 2490-2502(May 1968).

From Applied Superconductivity Conference and Exhibition, Austin, Tex. See CONF-671116.

Although superconductive tunneling has proved to be a very useful tool for investigating the phenomenon of superconductivity, it also has many potential device applications worth further development. Examples of such devices based on the tunneling of normal electrons might include an rf oscillator and amplifier, a low-temperature thermometer, and a generator and detector of microwave phonons. Examples of devices based on the tunneling of paired electrons, that is, the dc and ac Josephson effects, might include a magnetometer, computer elements, a generator and detector of microwave radiation, and a voltage standard. It is the purpose of this paper to briefly review normal electron tunneling as well as the dc and ac Josephson effects, how these different tunneling phenomena manifest themselves, and how these manifestations can be used for these several device applications. (auth)

29444 TUNNELING AND WEAK-LINK SUPERCONDUCTOR PHENOMENA HAVING POTENTIAL DEVICE APPLICATIONS. McCumber, D. E. (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Appl. Phys., 39: 2503-8(May 1968).

From Applied Superconductivity Conference and Exhibition, Austin, Tex. See CONF-671116.

A general physical picture of superconductor weak-link junctions is outlined with emphasis on phenomena relevant to device applications. The total junction current contains a dissipative quasi-particle component nearly analogous to the current in a normal-state junction plus an electron-pair component responsible for superconducting effects such as the Josephson effects. Stochastic relaxation processes such as have been commonly associated with vortex motion and flux flow sometimes perturb the pair current and must also be taken into account. (auth)

29445 SUPERCONDUCTIVITY CRITICAL CURRENT DENSITIES IN Ti–V ALLOYS. Vetrano, J. B.; Guthrie, G. L.; Kissinger, H. E.; Brimhall, J. L.; Mastel, B. (Battelle-Northwest, Richland, Wash.). J. Appl. Phys., 39: 2524-8(May 1968).

From Applied Superconductivity Conference and Exhibition, Austin, Tex. See CONF-671116.

Specimens of Ti–20% V alloy were heat treated to a β-solid-solution condition and then aged for several fixed times and temperatures below the β transus. X-ray and electron diffraction were used to determine the composition and distribution of the metallurgical phases produced by the aging treatments. These data were correlated with measurements of the superconducting transition temperature and critical current density. In order for these materials to carry reasonable supercurrent densities at 4.2°K, it is necessary that the matrix be rich enough in V for the transition temperature to be greater than 4.2°K and that there be present an array of flux-pinning sites. It was found that aging temperatures of 400°, 500°, or 600°C were required to insure the first condition. The flux pinners produced were ω particles in the case of the 400°C treatment and α precipitates in the case of the 500° and 600°C treatments. In many specimens, the superconducting-to-normal transition at a given value of applied field was spread out over a wide range of transport current rather than being abrupt as is usually the case. (auth)

29446 IMPROVED STABILIZED SUPERCONDUCTORS. Bindari, A. El.; Bernert, R. E. (Avco Everett Research Lab., Everett, Mass.). J. Appl. Phys., 39: 2529-32(May 1968).

From Applied Superconductivity Conference and Exhibition, Austin, Tex. See CONF-671116.

A new theory of the stable transition of a superconductor between normal and superconducting states is reviewed and data supporting this theory are presented. Data on copper-clad Nb–40% Ti are presented, and the slope for the variation of the critical current with wire diameter is found to be 1.5 for wire diameters between 0.005 and 0.05 cm. For copper-clad samples of this material, voltage–current data agree remarkably well with the new theory of stabilization. The importance of the superconducting transitional region is emphasized. (auth)

29447 MECHANICAL AND ELECTRICAL PROPERTIES OF DIFFUSION-PROCESSED Nb_3Sn–COPPER–STAINLESS STEEL COMPOSITE CONDUCTORS. Benz, M. G. (General Electric Research and Development Center, Schenectady, N. Y.). J. Appl. Phys., 39: 2533-7(May 1968).

From Applied Superconductivity Conference and Exhibition, Austin, Tex. See CONF-671116.

Diffusion-processed Nb_3Sn has high current density at high magnetic fields. When combined with copper or copper and

stainless steel in the form of a flat laminated tapelike conductor, it also has flexibility, low normal-state resistance, and the ability to withstand high tensile stress. This paper considers various laminated conductors that have been constructed, with emphasis on mechanical as well as electrical performance characteristics. Design methods and subsequent test evaluation for performance characteristics are discussed. (auth)

29448 RADIO-FREQUENCY LOSSES IN THE SUPERCONDUCTING PENETRATION DEPTH. Victor, J. M.; Hartwig, W. H. (Univ. of Texas, Austin). J. Appl. Phys., 39: 2539-46 (May 1968).

From Applied Superconductivity Conference and Exhibition, Austin, Tex. See CONF-671116.

Trapped flux has been shown to be responsible for a large part of the residual ac losses in both types I and II superconductors. The authors have made theoretical and experimental investigations of losses in the 40 to 400 MHz range to establish a more detailed low-field model. The surface resistance r_s, as given by Pippard, is exceedingly small for Sn, Pb, and other pure metals below about 0.95 T_c at these frequencies. As a consequence, trapped-flux effects provide the dominant losses in rolled-foil resonant circuits. The theoretical model is simply Ohmic losses in the normal regions of trapped fluxoids bounded by the penetration depth and the surface. This gives an added resistance $r_h = r_h(0)\ V(t)$, where the temperature function is $V(t) = (1 - t^4)^{-1/2}(1 - t^2)^{-1}$. The magnitude of the loss is predicted to be proportional to the density of fluxoids trapped, which in turn is assumed proportional to the background magnetic field for low fields. The experimental technique consisted of pulse determinations of circuit Q in the superconducting and normal state as a function of temperature and weak background magnetic field on cooling below T_c. The most detailed effort was made on pure tin foil from 60 to 350 MHz with background H fields up to 6 G. Data on these and on Sn–In, Pb–Sn, Ta, and Nb samples showed the function V(t) gave the best fit. The flux-trapping loss was linearly proportional to the cooling field. The Pippard surface-resistance term was separated out along with a very small residual loss, r_0. The latter was independent of field or temperature and could be annealed out. The Pippard term had a frequency dependence between $\nu^{1/2}$ and $\nu^{2/3}$ as expected. These results differed from Haden et al. in that no break in the decay rate was observed in the pure Sn circuits. This could be explained by the absence of an observable fluxoid core transition. The absence of a strong frequency dependence is consistent with Ohmic loss and ruled out a dominant hysteresis behavior. The nature of the flux-trapping loss is seen to make it the principal dissipating mechanism for most circuit applications since it resists annealing, does not depend upon impurities, and even though greatly reduced by nulling out external fields, may be partially self-induced due to thermoelectric effects on cooling. (auth)

29449 MACROVORTEX STRUCTURE IN HARD SUPERCONDUCTORS. Iwasa, Y.; Williams, J. E. C. (Massachusetts Inst. of Tech., Cambridge). J. Appl. Phys., 39: 2547-60(May 1968).

From Applied Superconductivity Conference and Exhibition, Austin, Tex. See CONF-671116.

The magnetization of hard superconducting wires, in the presence of a transverse magnetic field, can be induced to collapse by the application of a small, local field pulse. Under certain conditions the collapse may propagate along the wires in steps, leaving behind a spatially periodic variation in the remanent magnetization of the wire. The remanent magnetization is associated with discrete vortices of wire. A phenomenological explanation for the formation of the macrovortex structure is proposed. According to this explanation, the energy of magnetization, which is initially stored uniformly over a finite volume, is preferentially dissipated locally during the process of flux jumping, thereby raising the temperature of the region to the critical temperature. Although the formation of the macrovortex structure has thus far been observed only in unclad wire of high pinning strength, it represents a potentially important mechanism for the concentration of energy during a collapse of magnetization. (auth)

29450 PEAK-EFFECT STUDIES ON NIOBIUM NITRIDE. Maxwell, E.; Schwartz, B. B.; Wizgall, H.; Hechler, K. (Massachusetts Inst. of Tech., Cambridge). J. Appl. Phys., 39: 2568-71(May 1968).

From Applied Superconductivity Conference and Exhibition, Austin, Tex. See CONF-671116.

Observations of the temperature dependence of the peak effect in Nb–N between 4.2° and 1.35°K indicate that the field at which pinning effects set in is independent of temperature in this range. It is suggested that the repulsion between neighboring flux bundles acts to enhance flux pinning in the peak region. (auth)

29451 FLUX FLOW AND THERMAL STABILITY OF STABILIZED SUPERCONDUCTORS. Gauster, W. F.; Hendricks, J. B. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. J. Appl. Phys., 39: 2572-8(May 1968). (ORNL-P-3586).

From Applied Superconductivity Conference and Exhibition, Austin, Tex. See CONF-671116.

Test equipment has been designed in such a way that complete test cycles with bare or insulated compound conductor samples in unrestricted liquid-helium flow can be easily obtained. Sample currents up to 2000 A and fields to 80 kG can be used. An evaluation of the recovery points yields magnetoresistance data for the stabilizer material. Using these stabilizer resistance values, it is possible to split the total current into the superconductor and the stabilizer components. The tests show that, in general, the take-off points cannot be explained by the transition from nucleate to film boiling of the liquid helium. The V vs I curves in the flux-flow zone seem to indicate a heat-transfer law in the form $Q = h^* \tau^n$ with $n \simeq 2.5$ in the nucleate boiling regime. Tests with poorly stabilized samples (either bare or insulated) can be explained by assuming that parts of the sample are in the superconducting state, while other parts are in the normal state or in the flux-flow. (auth)

29452 MEASUREMENT OF THE SURFACE RESISTANCE OF SUPERCONDUCTING LEAD AT 2.868 GHz. Hahn, H.; Halama, H. J.; Foster, E. H. (Brookhaven National Lab., Upton, N. Y.). J. Appl. Phys., 39: 2606-9(May 1968). (BNL-11951).

From Applied Superconductivity Conference and Exhibition, Austin, Tex. See CONF-671116.

The surface resistance of superconducting lead at 2.868 GHz was determined from a measurement of the unloaded Q of a TE_{011} cavity. The results were compared to the analytical expression for the surface impedance of pure superconductors in the Pippard limit, which was worked out by Abrikosov et al. Adequate agreement was found by writing the reduced surface resistance in the form of $r = A\, r_{AGK} + r_0$, with r_0 being a residual resistance and A a constant. The best fit was obtained for A = 3.0, $r_0 = 2.2 \times 10^{-5}$ and the gap parameter $\Delta(0) = 1.97 k_B T_c$. (auth)

29453 MICROWAVE STUDIES OF THIN SUPERCONDUCTING FILMS. Soderman, D. A.; Rose, K. (Renssealaer Polytechnic Inst., Troy, N. Y.). J. Appl. Phys., 39: 2610-17(May 1968).

From Applied Superconductivity Conference and Exhibition, Austin, Tex. See CONF-671116.

The results of linear microwave transmission measurements on superconducting tin films are presented. The effects of residual reactances are noted and a comparison is made with calculations based on the BCS theory. Residual reactances are found to have a substantial effect on the nonlinear transmission measurements. They allow a clear separation of regions where superelectron depairing and "domain growth" dominate. Linear transmission measurements in the presence of a perpendicular magnetic field suggest the "domain growth" is the result of fluxon penetration. (auth)

29454 THE PINNING POTENTIAL AND HIGH-FREQUENCY STUDIES OF TYPE-II SUPERCONDUCTORS. Gittleman, Jonathan I. (Radio Corp. of America Labs., Princeton, N. J.); Rosenblum, Bruce. J. Appl. Phys., 39: 2617-21(May 1968).

From Applied Superconductivity Conference and Exhibition, Austin, Tex. See CONF-671116.

The electrical impedance of type-II superconductors as a function of frequency is discussed in terms of a "pinning potential." Many flux-pinning properties of the mixed state at any frequency can be treated in terms of such a potential and a simple phenomenological extension of the Bardeen–Stephen flux-flow theory. The form of the potential can be determined by various dc and high-frequency experiments. There is a critical frequency above which the impedance for subcritical currents becomes the impedance of the "ideal" mixed state. Much below this frequency the impedance is zero. This critical frequency is given by $\omega_0 = 2\pi c \rho_n \alpha / \phi_0^{1/2} H_{c2} H^{1/2}$. At microwave frequencies, almost all effects of flux pinning are absent, and the properties of the "ideal" mixed state are observed even in the most strongly pinned material. Such measurements have been used to determine the effective mass of the flux tube. (auth)

29455 STABILIZED, LEVITATED SUPERCONDUCTING RINGS. File, J.; Martin, G. D.; Mills, R. G.; Upham, J. L. (Princeton Univ., N. J.). Contract AT(30-1)-1238. J. Appl. Phys., 39: 2623-6(May 1968). (MATT-575).

From Applied Superconductivity Conference and Exhibition, Austin, Tex. See CONF-671116.

A levitated, stabilized superconducting ring is described. The ring, wound of 3310 turns of Nb–25% Zr 10-mil wire, has been operated with currents up to 16 A. It has been floated, with its associated Dewar, independent of all physical connections, for periods exceeding 7 hr. Ring stabilization criteria and a system to maintain the ring position are presented. (auth)

29456 SUPERCONDUCTIVE MICROWAVE MEANDER LINES. Gandolfo, D. A.; Boornard, A.; Morris, L. C. (Radio Corp. of America, Camden, N. J.). J. Appl. Phys., 39: 2657-60(May 1968).

From Applied Superconductivity Conference and Exhibition, Austin, Tex. See CONF-671116.

This paper describes the fabrication, testing, and application of superconductive meander lines. The meander line is a slow-wave circuit which consists of a number of parallel tapes uniformly spaced and connected in series. The tape length is equal to one-quarter wavelength for the center frequency of the line. Microwave signals propagate in the form of TEM waves along the tapes. Interaction between adjacent tapes leads to a dispersion curve which is in general nonlinear, but which possesses some nearly linear regions. Thus, either linear or dispersive performance may be obtained. Meander lines find application as slow-wave elements in low-noise amplifiers such as traveling wave masers, as linear delay lines, or as dispersive delay lines in pulse-compression filters. The present investigation deals with lead meander lines fabricated by the photoetch process. Reflection from and transmission through the meander line were measured by conventional techniques at room temperature, 77°K, and 4.2°K. A striking decrease in insertion loss was noted when the line became superconductive. Insertion loss and VSWR of the superconductive line were rapidly fluctuating functions of frequency, generally increasing and decreasing together. At numerous frequencies between 4.0 and 4.5 GHz, a 30 nsec delay line had insertion loss of 0.5 dB and VSWR less than 2. (Most of this insertion loss was probably due to nonsuperconductive input lines inside the cryostat.) For a comparison, a copper meander line, identical in geometry to the superconductive line was operated at 4.2°K, and was found to have insertion loss that was as much as 20 dB greater than that of the superconductive line. Meander delay lines should readily lend themselves to operation in a closed cycle refrigerator. (auth)

29457 RELAXATION OSCILLATIONS IN JOSEPHSON JUNCTIONS. Vernon, F. L. Jr.; Pedersen, R. J. (Aerospace Corp., Los Angeles). J. Appl. Phys., 39: 2661-4(May 1968).

From Applied Superconductivity Conference and Exhibition, Austin, Tex. See CONF-671116.

Investigation of the characteristics of Josephson tunneling in tin/tin/oxide/tin junctions showed that pulse voltages with sharp risetimes were being generated. Pulse amplitude across the junction remained constant and equal to the energy gap voltage V_g, but pulse frequency could be changed over a 25 :1 range by a change in bias voltage from 0 to an upper limit approximately equal to $V_g/2$. The oscillation mechanism is that of switching between the pair-current state of the junction at V = 0 and the quasiparticle-current state at $V = V_g$. The external circuit maintains the switching cycle and determines the output frequency characteristics. Using the L/R time constant of the external circuit and the assumed basic dc I(V) curve of the junction in the absence of relaxation oscillations, calculations were made that accurately describe the observed dc I(V) curves, frequency, and waveforms, including their dependence on bias voltage and magnetic field. (auth)

29458 PHYSICS OF PREPARATION OF JOSEPHSON BARRIERS. Schroen, Walter (Texas Instruments Inc., Dallas). J. Appl. Phys., 39: 2671-8(May 1968).

From Applied Superconductivity Conference and Exhibition, Austin, Tex. See CONF-671116.

Josephson barriers of the tunneling type are usually prepared by oxidation in room environment, but they degrade after storage at room temperature for a few days. This paper describes a preparation technique based on an oxygen glow discharge which renders stable, reproducible superconductive tunneling devices (STDs). The barrier may also consist of organic molecules (KPR, monocarbonic acids); lead serves as the superconducting metal. Simplified models are used to discuss the main features and advantages of the glow-discharge technique. Extensive investigation has shown that arrays of STDs can be fabricated using the photoresistant technique developed by Pritchard et al. The current-voltage and magnetic-field characteristics of these arrays are examined; it was found that they did not change during array storage at room temperature for more than 240 days and repeated temperature cycling from room temperature to 4.2°K. (auth)

29459 CRYOGENIC FLUX CONCENTRATOR. Brechna, H.; Hill, D. A. (to United States Atomic Energy Commission). U. S. Patent 3,384,849. May 21, 1968.

A flux concentrator magnet is described which has primary and secondary windings for producing a high magnetic field in the bore thereof having stacked discs forming radial slits sequentially spaced in progressive rotation from each other, and having removable, prefabricated coils between each disc. (AEC)

29460 A HIGH-SENSITIVITY SUPERCONDUCTING DETECTOR. Zimmerman, J. E.; Silver, A. H. (Ford Motor Co., Dearborn, Mich.). J. Appl. Phys., 39: 2679-82(May 1968).

From Applied Superconductivity Conference and Exhibition, Austin, Tex. See CONF-671116.

Weakly connected superconductors can function as very low power sensors by utilizing the coherence properties of superconductors. One configuration which has produced significant success incorporates a superconducting point contact and a small resistance element in a low-inductance superconducting circuit. When the critical supercurrent (i_c) of the point contact is of the order of ϕ_0/L, ($\phi_0 = h/2e$, L = inductance of the ring), that circuit exhibits coherent quantum behavior. Used as a parametric amplifier, it has been used to measure ultralow voltages, limited by the thermal noise fluctuations in the resistance element R. The voltage sensitivity is approximated by $8kTR/\phi_0$, where k is Boltzmann's constant and T the absolute temperature of the resistance R. We have measured 4×10^{-16} V across 1.7×10^{-10} Ω at 4.2°K with a signal-to-noise ratio approaching 10. The operation of this sensor follows from the Josephson oscillation of voltage-biased superconducting point contacts. A dc voltage V_0 across the resistance of the circuit produces an oscillating current at the angular frequency $\omega_J = 2\pi V_0/\phi_0$ and an oscillating voltage across the point contact at ω_J. Upon supplying an rf or microwave current at frequency ω_D, the point contact mixes ω_J and ω_D. Using a homodyne detector at ω_D of bandwidth larger than ω_J, we can retrieve the oscillation at ω_J. Direct measurement of this frequency ω_J yields V_0. Such superconducting circuits may be useful as cryogenic thermometers, as thermal radiation sensors, and in low-level spectroscopy. (auth)

Plasma and Thermonuclear Physics

Confinement and Heating of Plasma

Refer also to abstracts 28225, 29455, and 29525.

29461 (ORNL-TM-2204) FEASIBILITY OF POWER BY NUCLEAR FUSION. Rose, D. J. (Oak Ridge National Lab., Tenn.). May 1968. Contract W-7405-eng-26. 156p. Dep. CFSTI.

Power from nuclear fusion will be feasible if certain plasma physics and engineering problems can be solved simultaneously: Equilibrium plasma properties discussed here are the thermalization rates between ions, electrons, and fusion α particles; fuel burnup fractions for given electron and ion temperatures, given injection or heating energies, and specified plasma environmental conditions. The effect of the presence of α-particles and of unequal particle temperatures on plasma pressure and reaction rate are calculated. Typical operating conditions for a variety of plasmas typical of open or closed magnetic confinement systems are shown. New solutions to outstanding engineering problems are indicated, viz: a cellular niobium vacuum wall, cooled with lithium or fused salt; a beryllium or BeO pebble-bed moderator, with added graphite; magnetic stress supports of titanium. Many subsidiary problems are discussed. It is shown that fusion systems with output in the order of 10,000 electric megawatts may be economically attractive; cost of the fusion system "core" lies between $10 and $20/kWe, depending upon circumstances. The desired operating parameters in an open-ended fusion system may be achieved if the plasma pressure is a substantial fraction of the magnetic pressure, but not otherwise, and the task will be difficult. Closed magnetic field configurations will be more attractive, provided stability and system size problems can be satisfactorily resolved. The relevance of these studies to present fusion research is indicated. (auth)

29462 (UCID-5076) PROPOSED HIGH INJECTION RATE, VACUUM-TUBE-MODULATED, ELECTRON ACCELERATOR. Christofilos, N. (California Univ., Livermore. Lawrence Radiation Lab.). Oct. 25, 1965. Contract W-7405-eng-48. 13p. Dep. CFSTI.

The proposed new accelerator is described in some detail. (M.O.W.)

29463 (UCID-5104) PROPOSED HIGH INJECTION RATE, VACUUM TUBE-MODULATED, ELECTRON ACCELERATOR (RECENT DESIGN MODIFICATION). Christofilos, N. C. (California Univ., Livermore. Lawrence Radiation Lab.). Feb. 4, 1966. Contract W-7405-eng-48. 14p. Dep. CFSTI.

A brief description of the Astron accelerator is given along with cost estimates. (M.O.W.)

29464 EVALUATION OF TRANSFER COEFFICIENTS IN A TURBULENT PLASMA. Timofeev, A. V. (Inst. of Atomic Energy, Moscow). Nucl. Fusion, 8: 13-15(Apr. 1968).

A method is given of calculating and evaluating to an order of magnitude the diffusion coefficient and the frictional force in a turbulent plasma. By analogy with the expression for the ordinary diffusion velocity $\bar{v} = D(\nabla n/n)$, it is possible to introduce a coefficient of anomalous diffusion, which turns out to be equal to $D \approx (cT_\perp i/eH)\,(m/M)^{1/2}\,\tau^{-2}\,\mu^{-1/2}$. The study is based on the example of a turbulent state produced by the development of cyclotronic instability in a plasma with anisotropic velocity distribution of the ions. (auth)

29465 LIMIT OF THE PLASMA TEMPERATURE ATTAINABLE BY CYCLOTRON RESONANCE HEATING IN A MAGNETIC MIRROR. Kuckes, A. F. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). Phys. Lett., 26A: 599-600(May 6, 1968).

The resonant heating of charged particles confined by a static magnetic mirror is considered. The interaction of a particle with the electric and magnetic field of an electromagnetic wave leads to a stochastic increase of its transverse and longitudinal velocity. The limit on the plasma temperature predicted agrees with the experiments performed with electron and ion cyclotron resonance heating. (auth)

29466 QUASILINEAR THEORY OF CHERENKOV HEATING OF ELECTRONS IN AN INHOMOGENEOUS PLASMA. Dolgopolov, V. V.; Sizonenko, V. L.; Stepanov, K. N. (Inst. of Physics and Tech., Kharkov). Nucl. Fusion, 8: 41-9(Apr. 1968).

The quasilinear approximation was used to investigate the Cherenkov absorption by plasma electrons of the energy of an electromagnetic field created by external sources. The plasma is in the form of a cylinder of nonuniform radius located in a longitudinal magnetic field and the external sources are specific azimuthal currents flowing in coils surrounding the plasma cylinder. It is assumed that the magnetic pressure significantly exceeds the gas-kinetic pressure of the plasma, that the Larmor radius of the plasma particles is small compared with the distances within which the plasma density and the electromagnetic field change substantially, that the frequency of the field is significantly less than the electron gyrofrequency, and that the phase velocity is significantly greater than the thermal velocity of the ions, so that thermal motion of the ions can be ignored. An equation is derived for the diffusion of electrons in velocity space. From this equation it follows that the electron distribution along the velocity component perpendicular to the magnetic field does not change with time and that a plateau is formed on the curve characterizing the dependence of the distribution function on the longitudinal velocity component. The rate of formation of the plateau is different for different values of the velocity component perpendicular to the magnetic field. In the case of narrow wave packets a diffusion equation is obtained taking Coulomb collisions into account. The slope is found of the curve characterizing the dependence of the background distribution function on the longitudinal velocity component in the steady state, where diffusion on the waves is balanced by collisions. With narrow wave packets, if the frequency of the external currents coincides with that of the natural oscillations of the plasma cylinder (for a given wave vector value), saturation is reached in the absorption of electromagnetic field energy and, if the amplitudes of the external currents are fairly large, further amplitude increases do not lead to an increase in the absorbed power. If, however, the external current spectrum contains wave vectors corresponding to the natural oscillations of the plasma cylinder, the formation of a plateau does not lead to absorption saturation (the absorbed power remains proportional to the square of the external current amplitude). (auth)

29467 ECONOMICS OF POWER FROM PULSED FUSION REACTORS. Gilinsky, V.; Hubbard, H. (RAND Corp., Santa Monica, Calif.). Nucl. Fusion, 8: 69(Apr. 1968).

A brief comparison of the economics of power from fission and fusion reactors was made. (M.O.W.)

Diagnostics of Plasma

29468 ELECTRON-DENSITY PROFILES FROM LASER SCATTERING. Nodwell, R. A.; van der Kamp, G. S. J. P. (Univ. of British Columbia, Vancouver). Can. J. Phys., 46: 833-7 (Apr. 1, 1968).

The electron density as a function of position within a plasma jet has been determined by measurements of the coherent scattering of laser light. The electron-density profiles thus obtained are compared with those obtained from spectroscopic measurements. It is shown that the width of the satellites observed in earlier work may be accounted for by the electron-density gradients. (auth)

29469 CONDUCTIVITY AND TEMPERATURE OF PLASMAS PRODUCED BY A THETA-PINCH CONICAL DISCHARGE. NOTE II. Bono, Raffaele; Tondello, Giuseppe (Univ., Padua). Ric. Sci., 37: 923-8(Nov. 1967).

Temperature and electronic density measurements by spectroscopic means were carried out. The temperature of the plasma was calculated by evaluating the ratio of the intensity of line H_β and the underlying continuum. Sufficiently good agreement was found between the temperature values from the spectroscopic measurements and those calculated from the conductivity data. (auth)

29470 CONDUCTIVITY AND TEMPERATURE OF PLASMAS PRODUCED BY A THETA-PINCH CONICAL DISCHARGE. NOTE I. Bono, Raffaele; Tondello, Giuseppe (Univ., Padua). Ric. Sci., 37: 917-22(Nov. 1967).

Conductivity measurements were made in a hydrogen plasma produced by an annular theta-pinch conical discharge (≈5 kJ max energy). The discharge and the behavior of the shock waves produced were tested by means of a rotating-mirror camera. Plasma conductivity was determined using a rf differential device placed out of the gas. (auth)

29471 LASER MEASUREMENT OF ELECTRON DENSITY IN DENSE, HIGH-TEMPERATURE PLASMA. Boornard, A.; Nicastro, L. J.; Vollmer, J. RCA Eng., 11: 26-30(Dec.-Jan. 1965-66).

Temperatures in the range of 14,000 to 16,000°K are attainable in the potential core region of an argon plasma jet operating in the laminar mode. Measurement of the electron concentration in such high temperature plasma by conventional probe and microwave techniques is extremely difficult. The use of laser interferometer techniques appears to be promising and in this paper electron concentration measurements obtained using a He–Ne two-cavity laser interferometer are presented. Use is made of the 3.39 μm radiation to obtain a large phase shift: the visible 6,328-angstrom radiation is used for alignment and detection. The effects of scattering of the laser radiation by the plasma jet when operated in the turbulent mode are also reviewed. (Electron. Abstr. J.)

29472 ANISOTROPY OF THE ELECTRON VELOCITY DISTRIBUTION IN A REFLEX DISCHARGE MEASURED BY CONTINUOUS-WAVE LASER SCATTERING. Koons, H. C.; Fiocco, G. (Massachusetts Inst. of Tech., Cambridge). Phys. Lett., 26A: 614-15(May 6, 1968).

Ar^+ laser scattering observations in a reflex discharge indicate a temperature of approximately 30,800 and 13,570°K for the velocity components respectively parallel and perpendicular to the magnetic field. The anisotropy is related to the randomizing processes in the discharge. (auth)

29473 COMPARATIVE STUDIES OF PLASMA DIAGNOSTICS. Peterson, C. C.; Dienst, J. F. (RCA Lab., Princeton, N. J.). RCA Eng., 11: 18-25(Dec.-Jan. 1965-66).

Improvements in plasma diagnostics are of great interest because discrepancies often occur between the results of different types of plasma measurement; also, there is widespread demand for measurement methods which will supply more detailed characterization of a plasma rather than just one or two parameters. For these reasons, experiments were conducted in which Langmuir probe and microwave techniques were applied to the same plasma; these comparative studies have shown excellent agreement, and have led to better understanding of the plasmas. To obtain convenient and reproducible conditions, these plasmas were generated with high-purity rare-gas discharges and had electron densities in the range 10^9 to 10^{12} cm^{-3}. The comparative density measurements and the techniques, their refinements and some possible applications are discussed. (Electron. Abstr. J.)

29474 AN EXPERIMENTAL STUDY OF ARGON II LINE PROFILES IN A PULSED ARC PLASMA. Neufeld, Carl Richard. Vancouver, B. C., Univ. of British Columbia, 1967. Thesis.

Time-resolved spectrographic techniques were used to obtain the profiles of A II lines emitted from a laboratory plasma. For the dense, low-temperature plasma studied, most of the broadening of the observed lines results from interactions of the emitter with free charges in the surrounding plasma. The plasma was created by discharging a previously charged lumped-parameter delay line through a specially constructed vessel containing an argon-hydrogen mixture. By means of a rotating-mirror shutter, light from the discharge was admitted to the spectrograph during a time interval when the intensity of the A II lines was constant

to within about 10%. This time interval was chosen after monitoring the time dependence of the intensity of several A II lines with a monochromator-photomultiplier combination. A calibration spectrum was also obtained with a seven-step neutral density wedge in order to determine the response of the photographic emulsion. Of the twenty-four measureable A II lines recorded, fourteen yielded profiles which could be treated by a Voigt analysis. In this way the profiles could be corrected for the effects of instrumental and Doppler broadening. The electron number density was determined from the widths of the lines in multiplet 6 of the A II spectrum, previously measured by other workers. (Disser. Abstr.)

29475 ELECTRON CHARACTERISTIC OF A PROBE IN A MAGNETIZED PLASMA. Litvinov, I. I. Zh. Tekh. Fiz., 37: 2160-6(Dec. 1967). (In Russian).

The electron current to a cylindrical Langmuir probe in a uniformly magnetized plasma is calculated under the following assumptions; the axis of the probe is parallel to the direction of the magnetic field; the length of the probe is small with the electron mean free path; the radius of the probe is small compared with the electron Larmor radius; the electric field that decelerates the electrons is concentrated close to the probe within a shell whose thickness is of the order of the Debye radius and is small compared with the radius of the probe; and collisions have a negligible effect on the motion of an electron during the time required for it to traverse a distance equal to the length of the probe. The resulting probe characteristic for monoenergetic electrons is not linear. The probe characteristic for Maxwellianly distributed electrons is exponential, as in the absence of a magnetic field, and it reaches saturation at the plasma potential; the saturation current, however, is not proportional to the length of the probe and decreases with increasing magnetic field strength. The conditions for the validity of the calculated probe characteristic can be realized in rather strong magnetic fields; in an ordinary gas discharge plasma with an electron temperature of 4 eV these conditions can be realized for a 0.2-mm-diameter probe in fields with strengths up to 1 kOe. (ATD)

Kinetics of Plasma

Refer also to abstracts 28219, 28249, 29138, 29326, and 29603.

29476 (NP-17456) TIME-DEPENDENT AUTOCORRELATION FUNCTIONS FOR THE LIGHT SCATTERED BY A TURBULENT MEDIUM. Rijnhuizen Report 67-38. Pieroni, L.; Bremmer, H. (Stichting voor Fundamenteel Onderzoek der Materie, Jutphaas (Netherlands). Instituut voor Plasma-Fysica). Apr. 1967. 40p. Dep.

The following problem is considered: suppose a slab, confined between two infinite planes perpendicular to the z direction of a reference system, containing a slightly inhomogeneous medium characterized by a dielectric constant $\epsilon = \bar{\epsilon} + \delta\epsilon(x,y,z,t)$, with $\delta\epsilon\sqrt{\epsilon} \ll 1$. This model is used as an example for more general weakly inhomogeneous media to which the present theory may be applied just as well. (M.O.W.)

29477 (SU-IPR-224) STUDIES OF PLASMA OSCILLATIONS. Status Report No. 31, August 1, 1967-January 31, 1968. Crawford, F. W. (Stanford Univ., Calif. Inst. for Plasma Research). Feb. 1968. Contract AT(04-3)-326. 35p. Dep. CFSTI.

Further research results are described for each of the following: (1) ion wave propagation and positive column instabilities, (2) cyclotron echoes and collision measurements, (3) cyclotron harmonic wave phenomena, and (4) beam-plasma interactions. (M.O.W.)

29478 (NP-tr-1633) MEASUREMENT OF THETA PINCH PARAMETERS IN AN AZIMUTHAL MAGNETIC FIELD. Volkov, Ya. F.; Dyatlov, V. G.; Mitina, N. I. Translated for Culham Lab., Abingdon, Eng., from Zh. Tekh. Fiz., 37: 1792-6(1967). 9p. Dep. CFSTI. UK. JCL $1.10 fs, $0.80 mf.

A helium plasma produced in a theta pinch discharge with an azimuthal magnetic field was investigated. The time dependence of the electron temperature and plasma density was measured for different pressures in the system with and without an applied azimuthal magnetic field. The electron temperature was measured by optical methods from the relative intensities of the helium lines and from the absorption of soft x radiation in an aluminum foil. (auth)

29479 (NP-tr-1634) VALIDITY CONDITIONS OF THE RANDOM PHASE APPROXIMATION FOR NON-LINEAR WAVE INTERACTION IN A PLASMA. Zaslavskii, G. M. Translated for Culham Lab., Abingdon, Eng., from Preprint No. 47. 8p. (CTO-425). Dep. CFSTI. UK. JCL $1.10 fs, $0.80 mf.

A dynamic equation is considered describing the nonlinear interaction of waves of small amplitude in a plasma with discrete spectrum. The condition in which the random phase approximation is valid is obtained. The criterion depends on the form of the spectrum, the amplitude of the waves, and the distance between the harmonics in the spectrum. It is shown that in the limiting case of a continuous spectrum the random phase criterion is fulfilled automatically. The limit is determined for the spectrum of waves for which the kinetic equation is valid. (auth)

29480 (NP-tr-1643) OSCILLATORY STRUCTURE OF A QUASI-STATIONARY MAGNETOHYDRODYNAMIC SHOCKWAVE IN A PLASMA. Dolgov-Savelev, G. G.; Malinovskii, V. K.; Nesterikhin, Yu. E. Translated for Culham Lab., Abingdon, Eng., from Zh. Prikl. Mekh. Tekh. Fiz., No. 4, 111-12(1967). 10p. (CTO-465). Dep. CFSTI. UK. JCL $1.10 fs, $0.80 mf.

The equipment and techniques for studying the shock structure of a flowing plasma about a stationary object are briefly discussed. (M.O.W.)

29481 (NP-tr-1647) FURTHER DEVELOPMENT OF THE CASCADE HIGH POWER ARC CHAMBER. Maecker, H.; Steinberger, S. Translated for Culham Lab., Abingdon, Eng., from Z. Angew. Phys., 23: 456-8(1967). 12p. (CTO-477). Dep. CFSTI. UK. JCL $1.60 fs, $0.80 mf.

The cascade arc chamber for high-power cylindrical arcs consists of alternatingly stacked copper disks and insulating spacers, their central bore forming the tubular arc chamber. Each component of the chamber is briefly described. (M.O.W.)

29482 ANALYTICAL EXPRESSION OF THE IONIZATION CROSS SECTION FOR ATOM-ATOM COLLISIONS AND ON THE ION-ELECTRON RECOMBINATION IN DENSE NEUTRAL GASES. Drawin, Hans-Werner (EURATOM-CEA, Fontenay-aux-Roses, France). Z. Phys., 211: 404-17(1968). (In German).

Thomson's classical theory for the calculation of ionization cross sections in electron-atom encounters is applied for calculating the ionization cross section for atom-atom collisions. A very simple formula is obtained permitting a rapid calculation of the total ionization cross sections as a function of the kinetic energy E_e and the mass m_A of the ionizing atom, and of the binding energy E_i and the number ξ_i of equivalent electrons in the electronic shell to be ionized. The formula is in good agreement with quantum mechanical calculations and with experimental results. It can be applied to ionization from ground and from excited states. From this formula one obtains an expression for the rate coefficient for ionization in the center-of-mass system of the colliding particles. Then, the method of detailed balancing is applied to calculate the rate coefficient for ion-electron three-body collisional recombination with a neutral atom acting as the third body. This latter formula is applicable to recombination into the ground and into excited states. (auth)

29483 AUTOMODEL MOTION OF RARIFIED PLASMA. II. Gurevich, A. V.; Paritiskaya, L. V.; Pitaevskii, L. P. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz., 54: 891-904 (Mar. 1968). (In Russian).

A general qualitative description is given of various automodel motions of a quasi-neutral plasma. A detailed study is made of the cases of broadening of a model plasma into a more rarefied plasma and of a different temperature plasma into vacuum. (auth)

29484 AZIMUTHALLY LOCALIZED FLUCTUATIONS IN A LEVITATED TOROIDAL QUADRUPOLE. Roberts, M.; Alexeff, I.; Halchin, W. (Oak Ridge National Lab., Tenn.). Phys. Lett., 26A: 590-1(May 6, 1968). (ORNL-P-3696).

Long-persistence, azimuthally localized, density fluctuations have been observed in both lithium and hydrogen plasmas injected into an electromagnetically levitated toroidal quadrupole. (auth)

29485 BAND THEORY OF HELICON PROPAGATION. Baynham, A. C.; Boardman, A. D. (Royal Radar Establishment, Malvern, Eng.). J. Phys. A, 1: 363-6(May 1968).

The theory of helicon propagation in a periodic structure is formulated. It assumes the plasma to be cold and collisionless, and introduces a periodic modulation of electron density or of external magnetic field. The dispersion equation is shown to break up into bands of allowed and forbidden propagation. Numerical results are presented for the density modulated case, and it is seen that the band gap is proportional to magnetic field and that the band edges move to higher frequency as the magnetic field is increased. Some comments on the possibility of constructing a tunable filter, based on helicon propagation, are included. (auth) (UK)

29486 BREMSSTRAHLUNG EMISSION OF PLASMA IN A POSITIVE COLUMN BY COLLISIONS BETWEEN ELECTRONS AND ATOMS. Pfau, S.; Rutscher, A. (Ernst-Moritz-Arndt-

Univ., Greifswald, Ger.). Z. Naturforsch., 22A: 2129-31(Dec. 1967). (In German).

The experimental investigation of the continuum in the visible spectral region leads to results which are incompatible with an interpretation as molecular continuum. The observed current, pressure, and tube radius dependence of the emitted radiation indicates an origin by slowing down of the electrons on neutral atoms. This meaning is approximately analyzed on the example of low-current diffuse medium-pressure columns in Ne. The results obtained for Ne lead to the conclusion that, in opposition to the previous assumptions, the continuum of medium-pressure columns in the visible region represent a bremsstrahlung continuum for electron–atom collisions. (J.S.R.)

29487 COUPLING OF HIGH FREQUENCIES AND LOW FREQUENCIES IN TONKS–DATTNER RESONANCES. Widner, M. M.; Hsuan, H. C. S.; Lonngren, K. E. (Univ. of Iowa, Iowa City). Phys. Lett., 26A: 553-4(Apr. 22, 1968).

Recent experiments have shown that the normal Tonks–Dattner eigenmodes are drastically altered when a high power microwave signal impinges on a plasma column. This alteration allows the coupling of the high frequency signal to a spectrum of low frequency signals. A critical threshold behavior for low frequency excitation is found for both the incident signal and the average number density. (auth)

29488 DECAY INSTABILITY OF ELECTRON WAVE INTO LOWER AND UPPER HYBRID FREQUENCIES. Ohnuma, T.; Hatta, Y. (Tohoku Univ., Sendai). Phys. Lett., 26A: 620-1 (May 6, 1968).

The large-amplitude electron wave propagating perpendicular to a magnetic field is unstable with respect to decay into lower and upper hybrid modes. (auth)

29489 DENSE SUPERSONIC HYDROGEN JET IN HIGH VACUUM. Borovik, E. S.; Yuferov, V. B.; Skibenko, E. I.; Kobzev, P. M.; Kholod, Yu. V. (Physical-Technical Inst., Kharkov). Zh. Tekh. Fiz., 37: 2209-12(Dec. 1967). (In Russian).

In the experiments hydrogen gas issued at supersonic speeds from a Laval nozzle into a vacuum chamber with cooled walls and was condensed on a surface that was cooled to 4.2°K with liquid helium. It was found that cooling the nozzle and precooling the hydrogen before it entered the nozzle to 78 or 20°K sharpened the jet–vacuum boundary, reduced the liquid helium expenditure, and reduced the jet velocity and hydrogen expenditure required to produce a charge-exchange target of optimal thickness. The improvement is ascribed in part to the increase with decreasing temperature of the specific heat ratio of hydrogen, owing to freezing in of the rotational degrees of freedom of the molecule. It is concluded that gas jet hydrogen targets as thick as 10^{17} molecule/cm^2, and possibly thicker, can be produced, and that such targets will be useful as charge-exchange targets for injection of fast neutral atoms into plasma machines and for other purposes. (ATD)

29490 DYNAMICS OF THREE-WAVE PROCESSES IN PLASMAS. Fedorchenko, V. D.; Muratov, V. I.; Rutkevich, B. N. (Inst. of Physics and Tech., Kharkov). Nucl. Fusion, 8: 37-40 (Apr. 1968).

Traveling waves with a frequency of the order of 10^9 c/s were excited in a plasma column and their nonlinear interaction with the ionic sound waves ($f = 10^4$ c/s) was observed. At various distances from the input the authors recorded combination spectra showing the dynamics of the processes involved: the traveling-wave amplitude decreases and, at a distance of 29 cm from the input, falls to zero, its energy being redistributed to numerous satellites. The energy redistribution process is not periodic. The characteristic wave interaction time is found to be short ($\tau \sim 10^{-8}$ s), which indicates the efficiency of the process and enables conclusions to be drawn regarding the determinacy of the interacting wave phases ($\delta\omega \cdot \tau \ll 1$). (auth)

29491 EFFECT OF COLLISIONS ON WAVE MOTIONS IN A PLASMA WITH ANISOTROPIC PRESSURE. Sharma, S. R. (Univ. of Rajasthan, Jaipur, India). J. Phys. A, 1: 367-75(May 1968).

The development with time of small-amplitude oscillations, having harmonic spatial dependence, in a magnetoactive plasma is examined with the aid of moment equations. The plasma, which is assumed to be homogeneous and unbounded, has an initial anisotropic distribution of pressure. Neglecting the motion of the ions detailed consideration is given to the effect of collisions on the further development of the system for the propagation vector along or perpendicular to the magnetic field. For the collisionless case the dispersion relations derived by Jaggi are obtained. For the case of weak collisions explicit expressions for the damping and phase shift coefficients are evaluated. It is found that, for longitudinal propagation along the magnetic field, the collisional damping decreases or increases according to whether the perpendicular pressure is greater or less than the longitudinal pressure. High-frequency transverse waves may exhibit a collision-induced instability if the pressure anisotropy is large and of the appropriate sign. For extremely high-pressure relaxation frequencies the ordinary dispersion relations are recovered, in which only the momentum relaxation frequency contributes to the damping of the wave. (auth) (UK)

29492 ELECTROMAGNETIC SCATTERING FROM AN INHOMOGENEOUS, COLLISIONLESS PLASMA CYLINDER. Neuringer, Joseph L.; Stekert, James J. (AVCO Space Systems Div., Wilmington, Mass.). J. Math. Phys. (N. Y.), 9: 155-63(Jan. 1968).

An analytical investigation is presented of the coherent electromagnetic scattering at normal incidence from a quiescent, infinitely long, radially inhomogeneous, collisionless plasma cylinder. The inhomogeneity is characterized by an index of refraction $n = [1 - (\alpha/r)]^{\frac{1}{2}}$ such as would result from a line plasma source issuing plasma at a constant flow rate. Exact scattering solutions are obtained for both transverse electric and transverse magnetic polarizations of an incident plane wave. With k_0 and a representing the free-space wavenumber and cylinder radius, respectively, the partial radial wavefunctions and the scattered field are shown to depend markedly on the two nondimensional parameters β and η, where $\beta = k_0 a$ and $\eta = k_0 \alpha$. Numerical calculations of the differential scattering cross section for the TM mode show that forward scattering increases sharply with either increasing β or η although the increase is most sensitive to variations in β. The total scattering cross section is also shown to increase monotonically in the same fashion. Finally, it is observed that the scattering efficiency factor asymptotically approaches 2 in the limit as β and η both approach infinity, which is the same as that obtained for the homogeneous cylinder in the limit as β approaches infinity. (auth)

29493 ELECTROSTATIC OSCILLATIONS IN A SYNTHETIC PLASMA BEAM. Golovanivskii, K. S.; Lushchik, A. I. (Univ. of the Friendship of Nations, Moscow). Zh. Tekh. Fiz., 37: 2234-7(Dec. 1967). (In Russian).

A beam of cesium ions with a density between 10^6 and 10^8 cm^{-3} and an energy of up to 2.5 keV was neutralized by the electrons from a directly heated tungsten filament maintained at a potential of up to 50 V, traversed a space containing gas at a density not exceeding 10^{11} atoms/cm^3 for a distance of up to 25 cm, and was caught and analyzed with a five-grid electrostatic analyzer. The ion beam was stable when the neutralizer was cold. The collector current was examined for oscillations in the frequency range from 20 kHz to 40 MHz. Oscillations, whose intensities and frequencies depended on the heating current in the neutralizer, the neutralizer potential, the energy of the ions, and the distance from the ion source to the beam catcher, were observed in the following frequency ranges: 50 to 500 kHz, 5 to 15 MHz, and above 25 MHz. From the dependence of the frequencies and intensities of the oscillations and the velocity distribution of the electrons on the experimental conditions, it is concluded that the high frequency oscillations are probably longitudinal oscillations of the electrons near the electron Langmuir frequency, excited by Cherenkov radiation of the electrons resulting from the fact that the neutralizer was not an equipotential surface, and that the intermediate frequency oscillations, which were nearly monochromatic and sometimes simultaneously exhibited the fundamental and second harmonic, were parametric oscillations associated with different modes. The low frequency oscillations were far from monochromatic, sometimes exhibited their second and third harmonics, and had frequencies close to the ion Langmuir frequency. (ATD)

29494 ENERGY TRANSFER OF A QUASI-MONOCHROMATIC WAVE IN AN INHOMOGENEOUS MEDIUM. Jungwirth, K. (Inst. of Plasma Physics, Prague). Nucl. Fusion, 8: 23-7(Apr. 1968).

The derivation is presented of more general expressions than those usually obtained for the energy density W, the energy flux density $\vec{S}$, and the energy dissipation Γ of a quasi-monochromatic wave. The corrections as computed can be substantial, for example, in an inhomogeneous plasma in the region of frequencies ω for which the drift effects play an important role. (auth)

29495 EQUILIBRIUM OF FINITE LARMOR RADIUS PLASMA WITH ANISOTROPIC PRESSURE. Lacina, J. (Inst. of Plasma Physics, Prague). Nucl. Fusion, 8: 17-21(Apr. 1968).

The relations that exist between the pressure tensor, the electric current density in plasma and the self-consistent magnetic field for equilibrium plasma configurations in magnetic mirror systems are derived and discussed. The analysis starts from the distribution function of equilibrium plasma derived in earlier

work. It is found that the pressure tensor (appearing in these relations) is diagonal, with $P_{\xi\xi} \neq P_{\varphi\varphi} \neq P_{\eta\eta}$ ($P_{\xi\xi}$, $P_{\varphi\varphi}$ are the pressure components perpendicular to the lines of force, $P_{\eta\eta}$ that along the lines of force). The plasma pressure in magnetic mirror systems is usually strongly anisotropic also in the plane perpendicular to the lines of force ($P_{\xi\xi}$ differs considerably from $P_{\varphi\varphi}$) and the approximation $P_{\varphi\varphi} \approx P_{\xi\xi} \equiv P_{\perp}$ can no longer be used. The anisotropy is due to the strong dependence of the distribution function on the integral $P_{\varphi} = mrv_{\varphi} + e/c\, rA_{\varphi}$; the cause of this strong dependence lies in the finite Larmor radius (real plasma consists of spatially bounded beams with Larmor radius of the same order as the plasma radius). Because of the curvature of the magnetic surfaces, the relations between the macroscopic quantities are affected by both longitudinal and perpendicular plasma anisotropy. Equations describing these relations are derived for finite $\beta \approx 8\pi P/B^2$ and in the approximation $\beta \ll 1$. (auth)

29496 EXCITATION OF BULK-WAVE ON COLUMNS OF MAGNETIZED PLASMA. Gupta, K. C.; Singh, A. (Central Electronics Engineering Research Inst., Pilani, India). Int. J. Electron., 23: 433-41(Nov. 1967).

The excitation of the bulk-wave mode on a column of magnetized plasma by a ring of magnetic current outside the plasma is studied. The analysis is based on a solution of the inhomogeneous wave equation by the method of Fourier transforms. It is shown that slow waves with a large E_z field on the axis can be excited with high excitation efficiency. (auth) (UK)

29497 EXPERIMENTAL STUDY OF THE RADIATION OF ULTRAHIGH-FREQUENCY ELECTROMAGNETIC WAVES BY A PLASMA TRAVERSED BY AN ELECTRON BEAM. Kogan, M. I.; Sakharov, I. E. (Leningrad Polytechnic Inst.). Zh. Tekh. Fiz., 37: 2173-83(Dec. 1967). (In Russian).

The 3-cm-wavelength microwave power radiated by a helium plasma in a 0.3- to 5.0-kOe magnetic field when traversed by a 2.5- to 12-mA beam of 600- to 1500-eV electrons was investigated. The plasmas were produced in helium at pressures from about 0.02- to 0.08-mm Hg by a hot-cathode oscillating-electron discharge independent of the electron beam. The charged-particle density of the plasma was measured with a Langmuir probe that was calibrated to an accuracy of ±20% against the cutoff of 3-cm microwaves. The ultrahigh-frequency fields within the plasma were measured with two uhf probes and the microwave power radiated in the radial and axial directions at a wavelength of 3.05 cm (and in some experiments at 2.4 and 3.7 cm) was measured with the aid of three antennas (a horn and two open waveguide sections). Two of the antennas were employed to record separately the power radiated in the radial direction in waves polarized with the electric vector parallel and perpendicular, respectively, to the axis of the system. The measurements were performed by gradually increasing the plasma-producing discharge current with the helium pressure, magnetic field strength, and electron beam current and energy held constant and recording the radiated microwave power. The heights and widths of resonance peaks were measured and plotted on charts, which are reproduced and discussed. Resonances were noted at harmonics (up to the 11-th) of the Larmor frequency. These resonances were most marked when the harmonic of the Larmor frequency coincided with the upper hybrid resonance. The higher harmonics were more pronounced when the helium pressure was high than when it was low. Strong radiation was also noted when the frequency was midway between two successive harmonics of the Larmor frequency. The radiation was particularly strong when the detector frequency was between the Larmor frequency and its second harmonic. The radiated power was always considerably lower when the Larmor frequency coincided with the detector frequency than it was in weaker magnetic fields. In very strong magnetic fields when the Larmor frequency was higher than the detector frequency, there were observed one or several peaks in the radiated microwave power as the discharge current was varied. The results are discussed. (ATD)

29498 HIGH-FREQUENCY DIELECTRIC CONSTANT OF THE ELECTRON GAS. Da Providencia, J. (Univ., Coimbra). Phys. Lett., 26A: 630-1(May 6, 1968).

It is shown that the zero point motion of the plasmon mode yields a finite contribution to the imaginary part of the electron gas dielectric constant for frequencies above the plasmon frequency. (auth)

29499 INVESTIGATION OF PULSED TOROIDAL DISCHARGE IN CROSSED FIELDS. Berezin, A. B.; Bulyginskii, D. G.; Vil'dzhyunas, M. I. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Tekh. Fiz., 37: 2184-92(Dec. 1967). (In Russian).

The discharges described were produced in a 30-cm large-diameter 4-cm small-diameter glass torus containing hydrogen at 2×10^{-4} to 2×10^{-3} mm Hg in the presence of a quasi-steady longitudinal magnetic field of up to 7.5 kOe by the 10- to 25-kV discharge of a 1-μF capacitor between a hot tungsten cathode (emission current, approximately 1 A) and a coaxial molybdenum anode located in one section of the discharge tube. The optical spectra of the plasmas were photographed (the electron temperature was derived from the spectrum), the intensity of the visible radiation from the plasma, the transmissivity of the plasma for 4- and 8-mm wavelength microwaves, and the discharge current were recorded with oscillographs, and the correlation between the intensities of the visible radiation from different points within the plasma was investigated. It was found that a pulsed toroidal discharge in crossed fields can be employed to fill a toroidal magnetic trap with plasma to an electron density of 10^{13} cm^{-3} at low gas pressures of the order of 10^{-4}-mm Hg, where a breakdown in parallel fields cannot be achieved. Discharge current began to flow as soon as the anode potential was applied. The discharge current remained of the order of the cathode emission current for some hundreds of microseconds, depending on the gas pressure, the anode potential, and other factors, after which it suddenly increased by a factor of over 100. In the low-current regime the discharge current could be accounted for by the classical formula for the electrical conductivity of a plasma; in the high-current regime the plasma was unstable and did not meet the stability criterion of F. Hoh (Phys. Fluids, 6: 1184(1963)). In about 50% of the cases the transition from the low-current to the high-current regime was accompanied by an order-of-magnitude drop in the intensity of the visible radiation from the plasma and a corresponding drop in the plasma electron density. The reason for the sudden transition from one regime to the other is not understood. (ATD)

29500 INVESTIGATION OF THE CHARACTERISTICS OF THE PLASMA BURSTS PRODUCED BY A COAXIAL ELECTRODYNAMIC INJECTOR. Managadze, G. G.; Podgornyi, I. M.; Rusanov, V. D. Zh. Tekh. Fiz., 37: 2199-2205(Dec. 1967). (In Russian).

Hydrogen plasma bursts were produced by a coaxial plasma gun having a 7.5-cm-diameter outer electrode and a 3.5-cm-diameter inner electrode, fired by the up to 15-kV discharge of a 22-, 11-, or 5.5-μF capacitor. Hydrogen was injected into the gun at a distance of 17.5 cm from the muzzle, and the length of the inner electrode, measured from the injection point toward the muzzle, could be varied from 1.5 to 7 cm. After traversing a 150-liter vacuum chamber in which it lost much of its un-ionized gas, the plasma entered an 8.5-cm-diameter 150-cm-long glass drift tube in which there was maintained a longitudinal magnetic field of up to 3 kOe. To investigate the plasma bursts in the drift tube pickup coils were employed at different positions along the tube, 8-mm-wavelength microwave interferometry was used, measurements were made with an InSb detector of the absolute intensity of the 1- to 6-μ ir radiation from the plasma, and data were taken with a calorimeter that could be located at different positions along the tube. The characteristics of the plasmas depended considerably on the manner in which the gun was fired (on the hydrogen pressure behind the valve, the amplitude of the pulse to the valve, the delay between admission of hydrogen and firing of the gun, and the potential on and capacity of the capacitor bank); some of these dependences are presented graphically. Electron densities in the head of the plasma burst of over 2.5×10^{15} cm^{-3} were achieved. The velocity of the plasma burst increased with decreasing length of the inner electrode of the gun; velocities of $(9-10) \times 10^7$ cm/sec were obtained with a 1.5-cm-long inner electrode. The electron concentration was low in magnetic fields below 1 kOe, increased with increasing field strength in stronger fields, and approached saturation in magnetic fields above about 2 kOe. The energy of the plasma burst decreased from about 32 J at 10 cm from the entrance to the drift tube to about 20 J at the end of the tube (150 cm from the entrance). Most of this energy loss took place in the first 50 cm, and it is concluded that plasma bursts can be transported in a longitudinal magnetic field for distances of some meters without serious losses. (TSS) (ATD)

29501 KINETICS OF SLIGHTLY RELATIVISTIC PLASMA. I. Trubnikov, B. A. (Inst. of Atomic Energy, Moscow). Nucl. Fusion, 8: 51-7(Apr. 1968).

The kinetics of a slightly relativistic plasma is discussed on the basis of Darwin's Lagrangian, taking into account in the first nonvanishing approximation the effects of interaction retardation. Since the corresponding Hamiltonian cannot be written down explicitly, the author has devised a means of applying Bogolyubov's method using correlation functions to the case of a Lagrangian formalism involving velocity-dependent binary interaction. (auth)

29502 KINETICS OF SLIGHTLY RELATIVISTIC PLASMA. II. Trubnikov, B. A. (Inst. of Atomic Energy, Moscow). Nucl. Fusion, 8: 59-67(Apr. 1968).

A solution has been found to the equation obtained earlier for the binary correlation function of an electron plasma; this equation takes into account, in the first nonvanishing approximation, effects of interaction retardation. Transverse interactions of particles at great distances are shown to diminish proportionally to r^{-3}, as a result of which an isolated particle in the plasma is surrounded by a very extensive correlation cloud of currents. The collision integral obtained on the basis of Darwin's Lagrangian is shown to differ from one making precise allowance for retardation only in terms of the order $(v/c)^6$. (auth)

29503 MICROPARTICLE PLASMA. James, C. R.; Vermeulen, F. (Univ. of Alberta, Edmonton). Can. J. Phys., 46: 855-63(Apr. 1, 1968).

A study is made of a cloud composed of microparticles that are individually either positively or negatively charged. The plasma definitions that the total charge of the cloud is zero and the shielding distance is small compared to the dimensions of the system are taken to be satisfied. As a result, it is proposed that the cloud be called a microparticle plasma. Since the particle sizes vary over a range of values, the cold plasma many-fluid model is used to analyze the problem, with each fluid representing particles of a particular radius. It is assumed that there is a continuum between one fluid and the next. This model has been used to study plasma waves. Microparticle clouds have been set up in our laboratory in an attempt to realize a microparticle plasma. (auth) (Canada)

29504 NEUTRAL GAS TEMPERATURE IN ARGON MEDIUM PRESSURE DISCHARGE. Hayess, E.; Venzke, D.; Wojaczek, K. (Physikalisch-Technisches Institut, Berlin). Beitr. Plasmaphys., 7: 461-9(1967). (In German).

In the weakly ionized medium pressure column in Ar, measurements of the neutral gas temperature were made in the region Rp < 150 cm torr and i/R < 2 Acm^{-1} by means of fine thermoelements. The values obtained were controlled by determination of the mean gas temperature from indirect pressure measurements. Neutral gas temperatures in the tube center were found and the results agree satisfactorily with simple conclusions from the heat balance of the discharge column. (tr-auth)

29505 NONLINEAR COUPLING BETWEEN SLOW AND FAST WAVES IN A WAVEGUIDE PARTIALLY FILLED WITH A PLASMA. Hedvall, Per (Research Inst. of National Defence, Stockholm, Royal Inst. of Tech., Stockholm). Ericsson Tech., 22: 371-87(1966).

The nonlinear coupling between different modes in a parallel plate waveguide, partially filled with a cold and homogeneous plasma slab, is studied. The types of nonlinearities considered are those arising in the equations of motion and continuity for the electrons. It is shown that, by means of a slow (or fast) pump wave, one slow primary wave can nonlinearly excite another fast wave, which in contrast to the slow primary wave will have a considerable amount of field energy outside the plasma, and may thus be easily picked up by conventional couplers. Numerical calculations of the coupling coefficient are presented, and it is concluded that nonlinear coupling in this way, at least for very slow primary waves, can provide a method of getting an improved coupling to the slow plasma waves. (auth)

29506 OSCILLATIONS IN THE TP-D MACHINE. Tanaka, Yuji; Otsuka, Masamoto (Nagoya Univ., Japan). J. Phys. Soc. Jap., 24: 1146-52(May 1968).

Experimental results on oscillations in the plasma of the TP-D machine are described. The plasma is produced with a modified Duoplasmatron and diffused out along the magnetic line of force. With stronger magnetic field a "left-handed" rotation of the plasma column appears in its outer region, where an electron oscillation is excited and this causes an anomalous increase in the diffusion coefficient of electrons. Also the high frequency component of the electron oscillation is excited by the electron beam with a large spread in the beam velocity. (auth)

29507 PARAMETRIC AMPLIFICATION IN A PLASMA. Pointu, A. M.; Pomeau, Y.; Constantin, A. (Faculte des Sciences, Orsay, France). Phys. Lett., 26A: 567-8(Apr. 22, 1968). (In French).

A finite plasma having numerous resonance regions, behaves like a parametric amplifier when a small signal is applied on one of these resonances. An experiment is presented where a 2 mW signal at 2700 MHz is amplified with a power gain of 170, the band width being less than 1 MHz. (auth)

29508 PARAMETRIC EXCITATION OF COUPLED WAVES. II. PARAMETRIC PLASMON–PHOTON INTERACTION. Nishikawa, Kyoji (Kyoto Univ.). J. Phys. Soc. Jap., 24: 1152-8 (May 1968).

The general theory of the parametric excitation of coupled waves is applied to the parametric interaction of the electrostatic waves in a plasma with radiation whose frequency is close to the electron plasma frequency. On the basis of the hydrodynamic equations, the coupled equations for the electron plasma wave and ion acoustic wave are derived. The effect of the Landau damping is also considered phenomenologically. Using the coupled wave equations, the expressions for the threshold radiation intensity, the frequency shift at the threshold and the growth rate above threshold are obtained. In particular, the dependence of these quantities on the wave length of the electrostatic waves is discussed in detail. The results are compared with experiment of Stern and Tzoar. (auth)

29509 PASSAGE OF RELATIVISTIC ELECTRONS THROUGH A PLASMA. Rae, J. (Univ. of Glasgow). J. Phys. A, 1: 358-62(May 1968).

A general expression, in terms of thermodynamic Green functions, for the electron–electron direct scattering rate within a hot plasma is evaluated in the case where one of the electrons is relativistic. The result is used to calculate the rate of energy loss of a relativistic electron to a plasma in a wide, but specified, range of temperature and density. (auth) (UK)

29510 PRE-ELECTRODE VOLTAGE DROP DURING PLASMA INTERACTION WITH AN ELECTRIC FIELD IN AN ELECTRIC DISCHARGE TUBE. Kashkin, Yu. F. (Central Inst. of Aviation Motor Construction, Moscow). Izv. Sib. Otd. Akad. Nauk SSSR, Ser. Tekh. Nauk, No. 3, 129-34(1967). (In Russian).

The interaction of a plasma with an electrical field was studied by applying a voltage of 1 to 5 kV to coaxial copper electrodes at a gas pressure of 10^{-4} mm Hg std. Most of the experiments were carried out at a voltage of 1 to 2 kV because erosion of the copper electrodes was significant at $V_{apl.} > 2$ kV. The operating channel length was 75 cm, and the cross-section was 3 × 4 cm. The applied potential was varied from 50 to 150 volts, and the external resistance was varied from 0.24 to 100 ohms to obtain an electrode current of 1 to 400 A. The diameter of the cylindrical electrodes was carried from 0.01 to 0.3 cm. Plane electrodes with an area S = 7.5 cm^2 were also used. The pre-electrode voltage drop was determined from the volt–ampere characteristics. The experiments showed that the electrode material, area of the electrodes and type of gas had very little effect on the volt-ampere characteristics. The resistance of a plasma column 1 cm in length was found to be 0.002 ohm/cm, and did not depend on the distance of the electrode from the wall. The pre-electrode voltage was V_{PVD} = 8 volts when the electrode distance from the wall was >0.5 cm. On covering the electrode with teflon insulation, the pre-electrode potential drop increased linearly from 8 V in the absence of insulation to 18 V at an insulation thickness of 0.45 cm. The electrode temperature did not have an effect on the pre-electrode voltage drop. (TTT)

29511 PRODUCTION OF HIGH-FREQUENCY OSCILLATIONS IN A BEAM–PLASMA SYSTEM. Artemov, V. M.; Leont'ev, N. I.; Timoshenko, A. P.; Udovichenko, Yu. K. Zh. Tekh. Fiz., 37: 2193-8(Dec. 1967). (In Russian).

The production of microwaves by the interaction of up to 5-A 7-μsec pulses of 17.7-keV electrons with the plasma produced by the electrons themselves was studied. The electrons, after passing through a 15-cm-long 1-cm-diameter drift tube, entered the 4-cm-diameter up to 60-cm-long plasma chamber containing air at a pressure between 10^{-4} and 2×10^{-3} mm Hg. The length of the plasma chamber could be varied without breaking the vacuum. The measurements were performed in the presence of a longitudinal magnetic field, which could be varied from 0.3 to 4.0 kOe but was usually held at 2.5 kOe. The microwaves were recorded with the aid of dipole antennas, both inside and outside the plasma chamber, and a helical antenna inside the chamber, which recorded the longitudinal component of the oscillations. The charged particle density of the plasma was measured by the space charge method. Plasma densities up to 1.9×10^{11} cm^{-3} were recorded. The measured plasma densities were always considerably higher than the densities calculated on the assumption that all the ionization is due to the electron beam; this is ascribed to additional ionization resulting from the instabilities that developed in the plasma. The frequency spectrum of the emitted microwaves was investigated over the frequency range from 200 to 7500 MHz. The most prominent peak centered at 1300 MHz and had a half width of about 250 MHz. Smaller peaks were observed at 880, 1080, and 2400 MHz. The spectrum shifted toward the higher frequencies with increasing current and gas pressure, but this shift was not affected by the strength of the magnetic field. It is concluded from this that the 1300-MHz oscillations are associated with the plasma frequency, which calculations indicated to be about twice the peak radiation frequency. The intensity of the longitudinal oscillations was measured at different positions along the length of the

plasma chamber, and with different total lengths of the chamber. In a long (56-cm) chamber the longitudinal oscillations appeared at a distance of 10 cm from the entrance point of the beam and increased in intensity downstream, there being, however, a periodicity superposed on the monotonic growth. This is asc.ibed to the coherent plasma–beam interaction mechanism discussed by I. F. Kharchenko (At. Energ. (USSR), 14: 314(1963)). In shorter plasma chambers the onset of the longitudinal oscillations took place closer to the beam entrance point, and in a 48-cm-long chamber the oscillations began at the beam entrance point inself. Integral high-frequency powers in the 1200- to 1700-MHz frequency range of several kW were observed. (ATD)

29512 REDUCTIVE PERTURBATION METHOD IN NONLINEAR WAVE PROPAGATION. II. APPLICATION TO HYDROMAGNETIC WAVES IN COLD PLASMA. Kakutani, Tsunehiko (Kyoto Univ.); Ono, Hiroaki; Taniuti, Tosiya; Wei, Chauchin. J. Phys. Soc. Jap., 24: 1159-66(May 1968).

The Reductive Perturbation Method established in a previous paper is applied to the analysis of hydromagnetic wave of small but finite amplitude propagating in a cold plasma. It is shown that the basic system of equations belongs to the exceptional case defined in that paper and in the lowest order of perturbation it can be reduced to the Kortweg–de Vries equation for all angles of propagation. (auth)

29513 RELATIVISTIC KINETIC EQUATIONS INCLUDING RADIATION EFFECTS. I. VLASOV APPROXIMATION. Hakim, Remi (Temple Univ., Philadelphia); Mangeney, Andre. J. Math. Phys. (N. Y.), 9: 116-30(Jan. 1968).

In a preceding series of papers, the relativistic statistical mechanics of electromagnetically interacting particles were developed. Here a hierarchy of manifestly covariant equations is derived for the reduced densities. This hierarchy is valid at order one in a parameter which is closely related to radiation phenomena. At the lowest order (absence of correlation between particles), a kinetic equation is derived which is a modification of the relativistic Vlasov equation. The added term introduces the effects of the emission of collective radiation. A dimensional analysis shows that this term is important when $mc^2 \sim kT$, i.e., when the plasma is relativistic. The modified Vlasov equation is shown to be irreversible: an H theorem is proved. Several applications are studied: dispersion relations, hydrodynamical equations. The Einstein–Ritz controversy was also discussed on the connection between retarded actions and irreversibility. (auth)

29514 SOUND PULSES IN LOW-PRESSURE PLASMA. III. THE REACTION OF THE SOUND PULSES ON THE DISCHARGE PLASMA. Hayess, Erhard (Physikalisch-Technisches Institut, Berlin). Beitr. Plasmaphys., 7: 471-7(1967). (In German).

In the propagation of sound pulses in a low-pressure discharge, the local light emission was modulated in the form of a time-decaying sine oscillation. This is interpreted as a secondary perturbation of the plasma by the sound. First experimental results and model representation on the mechanism of the processes explained as ionization oscillations were presented. (tr-auth)

29515 STATIONARY FLOWS OF PLASMA ACCOMPANIED BY CONTRACTION OF THE PLASMA STREAM. Morozov, A. I. Zh. Tekh. Fiz., 37: 2147-59(Dec. 1967). (In Russian).

The one-fluid magnetogasdynamics model is used to discuss the steady laminar flow of a plasma in an azimuthal magnetic field with particular reference to the maximum attainable density and pressure of the plasma in a constricted region of the flow. In the final section of the paper there are briefly discussed the effects of the neglected dissipative processes and the two-component nature of the plasma. The following conclusions are reached: (1) Arbitrarily high densities and magnetic field strengths can be realized in stationary flows of an ideal plasma. (2) Although high densities and magnetic field strengths can be realized in flows at supersignal velocities, the highest densities and field strengths are realized only in flows at subsignal velocities. (3) There are dynamic effects that tend to stabilize the flow; these effects are more significant at supersignal velocities than at subsignal velocities, and their significance increases with increasing value of the ratio of the electric current to the mass flow rate. (4) Dissipative processes tend rather to reduce than to enhance the constriction of the flow, and thus tend to hinder the achievement of long plasma filaments; energy losses that tend to reduce the effective value of the specific heat ratio γ are exceptions to this rule. (ATD)

29516 THE PROPAGATION OF A TRANSVERSE ELECTROMAGNETIC WAVE IN A NONLINEAR, ANISOTROPIC, TIME-DEPENDENT PLASMA MEDIUM. Papa, R. J. (Air Force Cambridge Research Labs., Bedford, Mass.). Can. J. Phys., 46: 889-905(Apr. 1, 1968).

In a previous paper, a one-dimensional, inhomogeneous model was considered in describing the nonlinear interaction of a radio-frequency plane wave with a time-varying plasma. This paper extends the analysis to the anisotropic case, in which an elliptically polarized plane wave incident upon an electron-density profile induces changes in the electron density and electron temperature. A dc magnetic field parallel to the electron-density gradients causes the elliptically polarized wave to split into two distinct modes, a right-hand circularly polarized and a left-hand circularly polarized mode. The two modes are coupled through an energy-balance equation that governs the behavior of the electron temperature. The time-dependent response of the plasma may be found by numerically integrating an energy-balance equation and a continuity equation. The solution to the wave equation for the time-varying, inhomogeneous, anisotropic medium may be obtained through the use of the WKB approximation. The time scales for electron-temperature and electron-density changes are found to vary with incident flux, incident-wave ellipticity, and appropriate normalized plasma parameters. (auth) (Canada)

29517 THE THEORY OF ARTIFICIALLY PRODUCED MOVING AND STATIONARY LAYERS. II. Fuchs, Vladimir (Charles Univ., Prague). Beitr. Plasmaphys., 7: 449-60(1967). (In German).

In the system of the partial differential equation of the ionization wave theory, a spatial local and time periodical source is introduced, which represents a local periodic external perturbation. The solution of this equation system is found in the vicinity of the resonance frequency in analytical form. Both with respect to its formal form and its dispersion and amplification property, the formula corresponds satisfactorily to the artificially produced moving layers. Under certain conditions, an approximation representation of the stationary layers is obtained from the solution given by the extrapolation $\omega \to 0$. (tr-auth)

29518 THEORETICAL ANALYSIS OF A PULSED PLASMA ACCELERATOR. Hrynczuk, Jerzy. Pr. Inst. Masz. Przeply., No. 37, 65-9(1967). (In Polish).

A mathematical description is given of the motion of a plasma column in a pulsed accelerator. The plasma column is treated as a deforming rod having fixed points of fastening and subjected to the action of electrodynamic forces caused by the deformation of the column internal magnetic field. The results obtained show better agreement with experimental data than did previous theories based on a model of a rigid rod moving between the accelerator walls due to the action of electrodynamic forces. (IAA)

29519 THERMODYNAMICS OF WEAKLY RELATIVISTIC PLASMA. Trubnikov, B. A.; Kosachev, V. V. Zh. Eksp. Teor. Fiz., 54: 939-50(Mar. 1968). (In Russian).

Relativistic corrections to electromagnetic interaction are found to the thermodynamic functions of a completely ionized plasma. The plasma itself is described by Darwin's Lagrangian making it possible to take into account the relativistic effects accurately to terms of the order of v^3/c^3. It is shown that the simplified Darwin Hamiltonian is nonapplicable and the work of Krisan and Havas who used this Hamiltonian is erroneous. (auth)

29520 WAVE PROPAGATION IN A PARALLEL-PLATE WAVEGUIDE PARTIALLY FILLED WITH A HOT AND INHOMOGENEOUS PLASMA. Hedvall, Per (Research Inst. of National Defence, Stockholm. Royal Inst. of Tech., Stockholm). Ericsson Tech., 22: 389-401(1966).

Derivation and solution of the dispersion equations for TM waves in a parallel-plate waveguide, partially filled with a hot and inhomogeneous plasma slab, are given. Three types of modes exist: the "plasma" modes, the electrostatic modes, and the perturbed waveguide modes. It is shown that the major effects of the temperature on the dispersion curves are: (1) introduction of the electrostatic modes; and (2) introduction of a lower limit for the phase velocities, the limit being the mean thermal velocity of the plasma electrons. (IAA)

29521 WAVE–WAVE INTERACTION AMONG TRANSVERSE PLASMA OSCILLATIONS. Krishan, S. (Univ. of Alberta, Edmonton, Can.). Nuovo Cim., B, 55: 178-84(May 11, 1968).

The nonlinear wave–wave interaction for a one-dimensional spectrum of transverse plasma waves is studied in terms of emission and absorption of plasmons. In the collective oscillation limit $k^2 < \omega_p^2/c^2$, it is found that the waves do not interact. (auth)

29522 COLLISIONAL TRANSFER CONTRIBUTIONS IN THE QUANTUM THEORY OF TRANSPORT PHENOMENA. Imam-Rahajoe, R. Soesanto. Madison, Wis., Univ. of Wisconsin, 1967. 203p.

Thesis.

The quantum mechanical BBGKY equations are solved in terms of the phase space transformation functions. Introducing the molecular chaos approximation, the pair distribution function is obtained. In the binary collision approximation this leads to a generalized Boltzmann equation, in which the collisional transfer contribution is included. This equation is solved by the method of Chapman and Enskog, and expressions for the transport properties are obtained. The classical limit ($\hbar \to 0$) of the expressions are also derived. The heat flux is found to contain a contribution which is proportional to the gradient of the density. The significance of this term, which is of the order $\hbar^4$, is discussed. (Disser. Abstr.)

29523 COLLISIONLESS ABSORPTION AND EMISSION OF ELECTROMAGNETIC WAVES BY A BOUNDED PLASMA. Hinton, Frederick Lee. Pasadena, Calif., California Inst. of Tech., 1967. 91p.

Thesis.

The absorption and emission of electromagnetic waves by a hot bounded plasma can be greatly influenced by the collective behavior of the plasma. A homogeneous slab model of a hot plasma is used in a theoretical study of these collective effects. A boundary-value problem is solved to find the fields in the plasma when a plane wave is incident on the plasma boundary. Power is found to be absorbed from the incident wave because of the Landau damping of longitudinal plasma waves excited in the plasma. If the incident wave frequency is close to one of the plasma wave resonance frequencies, the absorption may be substantial, but only if the Landau damping rate is approximately equal to the radiation damping rate, i.e., if the plasma is "matched" to the radiation field. The width of an absorption line is the sum of the Landau damping and radiation damping widths. Electromagnetic noise radiation is emitted from a collisionless plasma because of the coupling of the field fluctuations in the plasma to the external radiation field at the plasma boundary. Plasma wave fluctuations are excited by fast electrons in the plasma and are reinforced by the collective response of the plasma at the resonance frequencies. Emission and absorption are related by Kirchhoff's law for a thermal plasma. For a nonthermal plasma the emission may be enhanced if there are many electrons in a high-energy tail of the distribution function. (Disser. Abstr.)

29524 RASPROSTRANENIYE ELEKTROMAGNITNYKH VOLN V PLAZME. (Propagation of Electromagnetic Waves in Plasma). Ginzburg, Vitaliy Lazarevich. Moscow, Izdatel'stvo Nauka, 1967. 683p.

The book reviews the propagation of electromagnetic waves of various frequency in uniform and nonuniform magnetoactive or isotropic plasma. Particular attention is paid to the propagation of waves under space and ionospheric conditions. A separate chapter is devoted to nonlinear phenomena in plasma in an alternating electromagnetic field. (ATD)

29525 ANGULAR DISTRIBUTION OF THE ENERGY AT THE OUTPUT OF AN END-TYPE COAXIAL ELECTRODYNAMIC ACCELERATOR. Derevshchikov, V. A.; Rusakov, N. V. Zh. Tekh. Fiz., 37: 2237-8(Dec. 1967). (In Russian).

A 1.54-cm^2-base, 3.5-cm-high hollow conical brass calorimeter was used to measure the angular distribution of the energy carried by the plasma ejected from a coaxial plasma gun. Measurements were made at 7 different angles to the axis of the gun with the calorimeter mounted at a distance of 7.5 cm from the center of the end of the anode. The temperature rise of the calorimeter was measured with a thermocouple. The angular distribution of the energy carried by the plasma was the more sharply peaked in the axial direction, the higher the potential to which the capacitor bank that powered the plasma gun was charged. This is ascribed to an increase in the effectiveness of the pinch and a decrease in the contamination of the plasma by vaporized insulation material with increasing potential (i.e., with increasing discharge current). Even at the highest investigated capacitor bank potential (1.75 kV), however, there was sufficient energy carried off at angles greater than 45° to the axis significantly to affect the efficiency of the plasma gun. The energy efficiency of the plasma gun was 56, 64, 72, and 72% at capacitor bank potentials of 0.5, 1.0, 1.5, and 1.75 kV, respectively. If one assumes that the energy recorded at angles greater than 80° to the beam is carried by radiation and integrates this over the full solid angle, one concludes that the radiant energy emitted by the plasma gun amounts to 20 to 25% of the energy stored in the capacitor bank. (ATD)

Production of Plasma

29526 (NP-17453) PLASMA PRODUCTION AND HEATING BY LASER RADIATION. Rijnhuizen Report 68-44. Kuepper, F. P. (Stichting voor Fundamenteel Onderzoek der Materie, Jutphaas (Netherlands). Instituut voor Plasma-Fysica). Feb. 1968. 28p. Dep.

A review of the present status of the theories and experiments of the production and heating of plasmas by laser radiation is given. This includes the problem of plasma confinement by external magnetic fields and by the laser radiation field itself. On the basis of the calculated models the possibility of the production of a thermonuclear plasma by laser radiation is discussed. It is concluded that with the present-day laser technology a thermonuclear plasma with a fusion energy release greater than the laser radiation energy may be produced on a time scale of nanoseconds. (auth)

29527 EXCITATION OF A HIGH-FREQUENCY ELECTRODELESS DISCHARGE. Kustov, E. F.; Arsen'ev, P. A. (Moscow Power Engineering Inst.). Zh. Tekh. Fiz., 37: 2167-72(Dec. 1967). (In Russian).

The production of plasma in a cylindrical tube by a high-frequency magnetic field in the presence of an external source of ionization that produces electrons at a uniform rate throughout the volume of the discharge tube is discussed. A stable high-frequency electrodeless discharge can arise only after the temperature reaches a certain critical value that depends on the nature of the gas and the radius of the discharge tube. The diffusion equation for the electron density in the presence of a uniformly distributed source of electrons in addition to electrons provided by ionization is solved (approximately) under the assumption that the electric field strength, on which the rate of production of electrons by ionization depends, is proportional to the distance from the axis of the tube. It is found that the electron density reaches a maximum at a certain distance from the axis of the tube and that an electrodeless high-frequency discharge cannot develop unless the radius of the region of maximum electron density is smaller than the radius of the discharge tube. A formula is derived for the radius of the maximum electron density region in terms of the difference between the electron and atom temperatures, the radius of the discharge tube, the electron diffusion constant, the ionization potential of the gas, the strength of the high-frequency field, and other relevant parameters. Cinematograms of the development of a 100 V/cm high-frequency discharge in argon in a 4 cm diameter discharge tube showed that in this case the diameter of the maximum electron density region was close to the calculated value of 0.8 cm, that a discharge was produced within 0.028 sec, and that the discharge continued to grow for 0.5 sec. (ATD)

29528 APPLICATION OF LASERS TO THE PRODUCTION OF HIGH-TEMPERATURE AND HIGH-PRESSURE PLASMA. Kidder, R. E. (Univ. of California, Livermore). Nucl. Fusion, 8: 3-12(Apr. 1968).

A brief account is given of the historical evolution of giant pulse lasers and of the level of performance of such lasers that has so far been achieved. Those aspects of the interaction of light with a plasma that are of importance in plasma heating are briefly reviewed, and a detailed treatment including the results of computer calculations is given of the heating of a spark within a homogeneous gas, the subsonic heating of an isolated gas sphere, and the pressure resulting from light-induced blow-off. It is concluded that existing giant pulse lasers have sufficient brightness to be potentially capable of producing plasmas with kilovolt temperatures and tens of megabar pressures, but that a major increase in output power will be required before this potential can be realized. The design of future giant pulse lasers that are particularly well suited to the achievement of extremely high output power at high brightness is discussed. (auth)

Stability of Plasma

29529 PLASMA INSTABILITIES DUE TO ION TEMPERATURE GRADIENTS. Porkolab, M. (Stanford Univ., Calif.). Nucl. Fusion, 8: 29-36(Apr. 1968).

The dispersion relation for an inhomogeneous, low-pressure, collisionless magnetized plasma with ion temperature gradients is solved numerically in the regime where the plasma dispersion function cannot be expanded in a power series. The plasma is found to be unstable to low frequency, electrostatic perturbation at least in the range $0 \lesssim k^2 r_i^2 \lesssim 5$, $0.2 \lesssim T_e/T_i \lesssim 5$, $\omega \lesssim k_\parallel v_i$, and possibly for a wider range of parameters (where r_i is the ion Larmor radius, T the temperature, v_i the ion thermal velocity, R the wave vector). It is believed that the magneto-ionic acoustic waves observed in a thermal potassium plasma are manifestations of such instabilities. Additional experimental evidence is given in support of this assertion. (auth)

29530 THE INVESTIGATION OF PLASMA MICROWAVE RADIATION IN THE PROCESS OF BEAM INSTABILITY DE-

VELOPMENT. Kirdyashev, K. P.; Slabovik, R. L.; Kharchenko, I. F.; Yaremenko, Yu. G. Radiotekh. Elektron., 13: 155-7(Jan. 1968). (In Russian).

The interaction of a concentrated electron beam with a plasma was investigated at a beam current of 3 A, an accelerating voltage of 12 kV, a pulse duration of 10 to 150 μsec, and a pressure of 5×10^{-3} mm Hg std in a longitudinal magnetic field of 1000 to 1300 Oe. The high-frequency oscillations were recorded at 500 to 1000 and 8900 to 9850 Mc. The time characteristics of the emissions were determined during the beam instability. Testing the plasma with a 3-cm signal showed that the plasma density exceeded 10^{12} cm^{-3}. Thus the break in intensive emission in the decimeter region is associated with an increase in plasma density, and the emission in the 3-cm region occurred at a plasma frequency corresponding to an electron concentration of 10^{12} cm^{-3}. The data indicate that high radiation temperatures are found over the entire length of the beam current pulse. The high temperatures are not due to thermal emission but rather to beam instabilities leading to sporadic emission of radiation. (TTT)

29531 STABILIZATION OF PLASMA IN A THETA PINCH. Norwood, Joseph Jr. Hoboken, N. J., Stevens Inst. of Tech., 1967. 122p.

Thesis.

A brief history of the development of the theta pinch is given. The various instabilities which beset the theta-pinch plasma are described in some detail and the importance of the role of magnetic field uniformity is demonstrated. Sources of the field nonuniformity are delineated and discussed. These include the collector plate geometry, the nonlinear effect of the plasma, end effects in the coil, discontinuity in gap spacing as the current flows into the coil, and effects due to the alteration in axial current distribution due to skin effect. Next the various methods for stabilizing the plasma by eliminating field gradients are described and a new method is proposed employing a flux concentrator. The advantages of this method are compared with other techniques which have been used. Results of quantitative measurements of the field uniformity in an exact half-scale model theta pinch are described and discussed. These measurements include flux concentrator and collector plate extension effects as well as the effect of the conducting mass of the collector plate structure which excludes high-frequency flux. Finally, experiments are described which suggest that theta pinches without extensions are capable of being stabilized by flux concentrator techniques. (Disser. Abstr.)

29532 INSTABILITY OF PLASMA WITH AN ISOTROPIC DISTRIBUTION FUNCTION. Korablev, L. V.; Rudakov, L. I. Zh. Eksp. Teor. Fiz., 54: 818-21(Mar. 1968). (In Russian).

It is shown that if the ion or electron velocity distribution function is isotropic but is not the Maxwell one, such a state of plasma may prove unstable with respect to perturbations with a wavelength of the order or smaller than the average Larmor radius of particles of this kind. (auth)

Shielding

Refer also to abstracts 28497, 28616, 28905, 29786, and 29839.

29533 (AED-C-33-04) BIBLIOGRAPHIEN ZUR KERNFORSCHUNG UND KERNTECHNIK. SEKTION 33. ABSCHIRMUNG RADIOAKTIVER STRAHLUNG IN DER KERNPHYSIK (SHIELDING). (Bibliographies in Nuclear Science and Technology. Section 33. Shielding of Radioactive Radiation in Nuclear Physics). Schmidt, Anton (comp.) (Zentralstelle fuer Atomkernenergie-Dokumentation, Frankfurt am Main (West Germany)). Mar. 1968. 123p. (In German and English). Dep.

A listing of 437 articles on various aspects of accelerator, reactor, and space shielding is presented. An author index is also included. (M.O.W.)

29534 (UCRL-Trans-1367) ON THE STOPPING OF FAST-MOVING PARTICLES IN PASSAGE THROUGH MATTER. Bloch, F. Translated by Jack Patrick (Univ. of California Lawrence Radiation Lab., Berkeley), from Ann. Phys. (Leipzig), (5), 16: 285-320(1933). 56p. Dep. CFSTI. JCL $5.60 fs, $2.00 mf.

The postulate which is the basis for the calculation is this: the change in momentum of the projectile particle during the collision shall always be small in comparison to its original momentum. For the non-relativistic case it has been shown previously that under this assumption of insignificant momentum transfer to the projectile particle, the effect on the atom may be described as in the classical theory by means of a Coulomb field source moving with uniform velocity in a straight line. Essentially this result is used and that which follows from it, the method of treating the problem of the Bethe calculation in momentum space, is deduced on account of the rather close analogy with the classical view. The only additional assumption that is made is that the mean velocity of the electron in the atom shall be sufficiently small in comparison to the velocity of the incoming particle. An expression for the stopping formula is then obtained in closed form. This expression contains as limiting cases the classical stopping formula and the Bethe stopping formula and may be designated as the generalization of these formulas. (M.H.R.)

29535 EVALUATION OF FUNCTIONALS ARISING IN MONTE CARLO SOLUTION OF CONJUGATED EQUATIONS FOR RADIATION TRANSPORT. Khisamutdinov, A. I. Zh. Vychisl. Mat. i Mat. Fiz., 8: 467-71(Mar.-Apr. 1968). (In Russian).

Integral equations for γ-quanta transfer are calculated, assuming the γ quanta are interacting with the media, and are undergoing either absorption or Compton scattering. (R.V.J.)

29536 MEASUREMENTS ON THE ATTENUATION OF 4 MV X RAYS IN BARYTES CONCRETE. Ormsby, P. L.; Roberts, G. C. (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Brit. J. Radiol., 41: 235-6(Mar. 1968).

Data are presented on the attenuation of primary x radiation from a 4 Mv linear accelerator in barytes concrete of 3.4 g/cc density. Measurements were made with an ionization chamber placed against the wall of the treatment room on the central axis of the x-ray beam at a distance of 5.5 m from the target. Readings were taken as successive layers of concrete brick were erected. The attenuation curves obtained were closely exponential. (C.H.)

29537 BETON V ZASHCHITE YADERNYKH USTANOVOK. (Concrete in Shielding of Nuclear Installations). Broder, D. L.; Zaitsev, L. N.; Komochkov, M. M.; Mal'kov, V. V.; Sychev, B. S. Moscow, Atomizdat, 1966. 239p.

This book is intended for designers of nuclear devices and readers working in the nuclear industry. Methods of techniques for swift evaluation of various nuclear shieldings are presented. Approximate methods of calculating concrete shieldings are covered in the following sequence: the determination of emitted radiation and its distribution, of the distribution of radiation fluxes along the thickness of the shield, and of the permissible radiation levels beyond the shield. Particular attention is given to the shielding of high-power accelerators. The following topics are covered: general information on biological shields for nuclear installations; reactors and accelerators as radiation sources; calculation of the attenuation of medium-energy neutron and gamma-quantum fluxes in shielding; calculation of attenuation of radiation from high-energy particle accelerators; penetration of neutrons through concretes; gamma-radiation penetration through concretes and formation in concretes; radiation heating of concrete shielding; and some problems in optimal-shield selection. (TSS) (ATD)

29538 GREEN'S FUNCTIONS FOR THE ONE-SPEED TRANSPORT EQUATION IN SPHERICAL GEOMETRY. Erdmann, R. C. (Univ. of California, Los Angeles); Siewert, C. E. J. Math. Phys. (N. Y.), 9: 81-9(Jan. 1968).

Several problems in one-speed neutron transport theory for spherically symmetrical systems are discussed. The singular eigenfunction expansion technique is used to construct a solution for a specific finite-slab Green's function. This slab solution is then used to construct the finite-medium spherical Green's function by extending the point-to-plane transformation concept. For the general case, the expansion coefficients are shown to obey a Fredholm equation, and first-order solutions are obtained; however, in the infinite-medium limit the solution is represented in closed form. In addition, the solution for the angular density in an infinite-medium due to an isotropic point source is developed directly from the set of normal modes of the transport equation. A proof that the result so obtained obeys the proper source condition at the origin is given. (auth)

Solid-State Physics

Refer also to abstracts 27707, 28227, 28248, 28263, 28803, 29270, 29409, 29840, 29852, and 30045.

29539 (64-RL-(3754-M)) MAGNETIC BREAKDOWN AT INTERMEDIATE FIELDS. Duke, C. B.; Harrison, W. A. (General Electric Co., Schenectady, N. Y. Research Lab.). July 29, 1964. 10p.

It is demonstrated that the probability of diffraction of an electron at a Brillouin-zone face is given at all magnetic fields by the simple exponential that is suggested by the high- and low-field limits. (auth)

29540 (COO-1053-9) TRANSMISSION OF 1-25 keV IONS THROUGH CRYSTAL FOILS. Hines, R. L. (Northwestern Univ., Evanston, Ill.); Andreen, C. J. (Chalmers Tekniska

Hogskola, Goteborg (Sweden)). May 1967. Contract AT(11-1)-1053. 18p. (CONF-670966-1). Dep. CFSTI.

From Conference on Atomic Collisions and Penetration Studies with Energetic (keV) Ion Beams, Chalk River, Ontario.

The penetration of low-energy ions in crystals can be measured in a direct way by using metal target foils made by vacuum evaporation. Good crystals of gold and iron have been prepared with thicknesses between 200 and 1000 Å. The foils are mounted on electron-microscope grids held in a goniometer that tilts the film normal and rotates the film about its normal. The transmitted ion current is measured with an electrometer in the forward direction as a function of foil orientation. Strong channel peaks are observed in transmission and energy loss for H^+, D^+, and He^+ ions in gold and iron. A detailed study of the critical angles for H^+, D^+, and He^+ ions in gold agrees with Lindhard's theoretical predictions. (auth)

29541 (COO-1057-38) LOW-RATE THERMOLUMINESCENCE DECAY PROCESSES SHOWN IN BUILDING STONES. Zeller, Anke N. (Kansas Univ., Lawrence). Mar. 1, 1967. Contract AT(11-1)-1057. 4p. Dep. CFSTI.

Building stone samples were collected from outside and inside walls of a barn constructed in 1927 near Junction City, Kansas. One portion of each sample was used to determine the natural thermoluminescence; another portion was irradiated with a total dose of 3×10^6 γ radiation from ^{60}Co. The relative thermoluminescence, which expresses the natural as a percentage of the saturated thermoluminescence, was then calculated. The study shows that natural thermoluminescence is very much affected by temperatures attained under natural climatic conditions. The potential of the thermoluminescence method for archaeological studies is briefly discussed. (TSS)

29542 (ISS-67/38) STUDIO DEI PUNTI CRITICI DELLA STRUTTURA A BANDE DELLA GRAFITE MEDIANTE THERMOMODULAZIONE DELLA RIFLETTIVITA. (A Study of the Critical Points of the Band Structure of Graphite by Means of Thermo-Modulated Reflectance). Balzarotti, A.; Grandolfo, M. (Istituto Superiore di Sanita, Rome (Italy). Laboratori di Fisica). Oct. 30, 1967. 37p. (In Italian). Dep.

The differential reflectance of graphite crystals was measured in the energy range 4 to 6.5 eV by modulating the optical constants of the crystals with temperature. The results indicate that the strong peak around 5 eV, previously observed in absolute reflectivity measurements, is due to an M_1 saddle point singularity. In addition they show a structure at 5.96 eV, resolved for the first time, which is related to an M_0 transition occurring at the center of the Brillouin zone. (auth)

29543 (NYO-3330-18) THE INVESTIGATION OF THE USE OF NUCLEAR RADIATION IN THE PREPARATION OF OPTICAL MASER MATERIALS. Final Report. Sadowski, Henry; Held, Kalman; Beckerley, James (Radioptics, Inc., Plainview, N, Y.). Aug. 14, 1967. Contract AT(30-1)-3330. 106p. Dep. CFSTI.

Exposure of ruby lasers and a variety of neodymium-doped glass lasers to cobalt-60 gamma-ray doses of a few tens of megarads followed by optical bleaching and thermal annealing cycles (up to two hours at 400°C) has been found to increase the slope efficiency of some of the lasers. The effect is reproducible and constitutes an upgrading of the lasers for pumping energy inputs above certain minimum levels. Processed lasers are stable at room temperature. Experimental results are summarized and the commercial prospects for use of the process are discussed. It is noted that in addition to upgrading lasers, the process may be valuable as a means for controlling the quality of lasers, that is, controlled upgrading of a group of lasers to a predetermined level of performance. (auth)

29544 (PRNC-16) NEUTRON DIFFRACTION PROGRAM. Progress Summary Report No. 1. Almodovar, Ismael (Puerto Rico Nuclear Center, Mayaguez). Mar. 1963. Contract AT(40-1)-1833. 6p. Dep. CFSTI.

IRON — neutron diffraction pattern of powdered
CALCIUM TUNGSTATES — neutron diffraction data on $CaWO_4$
BARIUM NICKELATES — neutron diffraction studies of $BaNiO_2$
IRON SILICATES — neutron diffraction studies of Fe_2SiO_4
NEUTRON-DIFFRACTION ANALYSIS — structural studies using (D.L.C.)

29545 (PRNC-84) NEUTRON DIFFRACTION PROGRAM. Progress Summary Report No. 4. Kay, M. I.; Almodovar, I.; Gonzalo, J. A.; Cromer, D. T.; Okada, K. (Puerto Rico Nuclear Center, San Juan). Apr. 1966. Contract AT(40-1)-1833. 53p. Dep. CFSTI.

COPPER FORMATES — structure of tetrahydrate of, dielectric constant and neutron diffraction studies of
ALUMS — structure of cesium, x-ray and neutron diffraction studies of
CESIUM ALUMINUM SULFATES — structure of $CsAl(SO_4)_2 \cdot 12H_2O$, x-ray and neutron diffraction studies of
TARTARIC ACID — structure of d-, x-ray and neutron diffraction studies of
MANGANESE ALLOYS & SYSTEMS — Mn-Pd, magnetic structure of $\zeta - Pd_3Mn_2$, neutron diffraction study (D.L.C.)

29546 ANGULAR LIMIT TO A CLASSICAL DESCRIPTION OF PROTON CHANNELING. Desalvo, A. (Univ., Bologna. CNR, Rome). Phys. Lett., 26A: 608-9(May 6, 1968).

A lower angular limit to a classical orbital description of proton channeling, when the continuous string model is assumed, is derived. (auth)

29547 ANALYSIS OF MOESSBAUER HYPERFINE STRUCTURE IN THULIUM METAL BELOW THE NEEL TEMPERATURE. Cohen, R. L. (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., 169: 432-6(May 10, 1968).

Mössbauer-effect measurements of the hyperfine structure of ^{169}Tm below the Néel temperature are presented and analyzed. The interpretation is based on the neutron-diffraction analysis of the magnetic structure, and assumes fast relaxation among the exchange-split levels of the lowest J multiplet. The assumption of slightly incommensurate magnetic and crystal unit cells is essential to the successful interpretation of the data, since it produces a continuous distribution of hyperfine fields, as is observed. (auth)

29548 APPLICATIONS OF EXTREMELY NARROWED NMR IN SOLIDS. Gill, D. (Univ. of California, Berkeley). Phys. Lett., 26A: 544-5(Apr. 22, 1968).

The measurement of the Suhl-Nakamura interaction in MnF_2 and Ruderman-Kittel interactions in light metals may be facilitated by pulsed-NMR techniques which combine fast 90°-pulse trains with conventional spin-echo. (auth)

29549 CHANNELLING OF FAST CHARGED PARTICLES THROUGH CRYSTALS. Cowley, J. M. (Univ. of Melbourne). Phys. Lett., 26A: 623-5(May 6, 1968).

The criterion of incident beam coherence determines whether a wave or particle theory should be used to describe channeling. The approximation to the complete wave theory appropriate for protons will give the same results as a particle theory. (auth)

29550 DEPENDENCE ON CONCENTRATION OF THE DENSITY OF STATES N(0) IN Nb-Mo ALLOYS AND ITS EFFECT ON THE THERMAL CONDUCTIVITY. Sousa, J. B. (Oxford Univ.). Phys. Lett., 26A: 607-8(May 6, 1968).

A strong dependence of the lattice thermal conductivity on composition, observed in the Nb-Mo system, can be explained in terms of corresponding changes of the density of states N (0). (auth)

29551 DECHANNELING DUE TO DISLOCATIONS. Quere, Y. (Centre d'Etudes Nucleaires, Fontenay-aux-Roses, France). Phys. Lett., 26A: 578-9(Apr. 22, 1968). (In French).

The effect of dechanneling due to dislocations is evaluated with Lindhard's theory. This effect is represented by the existence, around the dislocation, of a dechanneling cylinder of diameter: $\bar{\lambda} = (bdaE/\alpha Z_1 Z_2 e^2)^{\frac{1}{2}}$, E is the energy of the particule (charge $Z_1 e$), b the Burgers vector, d the atomic distance along the considered channel, Z_2 the atomic number of the crystal, a the screening radius, α a parameter respectively equal to 15.8 and 5.6 for edge- or screw-dislocations. There is agreement between this formula and an experimental value measured in aluminum. (auth)

29552 DIFFRACTION OF LOW-ENERGY ELECTRONS BY CRYSTALS. Beeby, J. L. (Atomic Energy Research Establishment, Harwell, Eng.). J. Phys. C, 1: 82-7(Feb. 1968).

A formulation of the problem of low-energy electron diffraction from crystal structures is given, using multiple scattering theory. Only elastic processes are considered. The resultant formulae are straightforward to compute and can be applied to model surfaces of arbitrary complexity, provided they are regular. (auth) (UK)

29553 DIRECT MEASUREMENT OF THE OXYGEN VACANCIES PRODUCED IN CALCIUM TUNGSTATE BY FAST REACTOR NEUTRONS. Chu, K. C.; Kikuchi, C. (Univ. of Michigan, Ann Arbor). Phys. Rev., 169: 752-7(May 15, 1968).

The usefulness of electron spin resonance for the direct measurement of defect concentration is pointed out. Fast-neutron irradiation results in a variety of paramagnetic centers in calcium-tungstate single crystals. From the g tensors, the hyperfine interaction, and the result of a uniaxial-stress experiment, one of the centers has been identified as due to paramagnetic tungsten associated with a displaced nearest-neighbor oxygen. The concen-

tration of oxygen displacements is measured by comparison with a copper-sulfate standard and is calculated using the Kinchin–Pease theory. The measured and calculated values are in good agreement. (auth)

29554 EFFECT OF GAMMA-RAY IRRADIATION ON THE FIRST CONSTANT OF MAGNETIC CRYSTALLOGRAPHIC ANISOTROPY OF SINGLE-CRYSTAL NICKEL FERRITES AND NICKEL–COPPER FERRITES. Sirota, N. N.; Ges, A. P. (Inst. of Solid State and Semiconductor Physics, Minsk). Dokl. Akad. Nauk, BSSR, 11: 774-6(Sept. 1967). (In Russian).

Single crystals of $NiFe_2O_4$ and of nickel–copper ferrite containing 25 to 50% $CuFe_2O_4$ were grown, and the temperature dependence of the constant of anisotropy was measured before and after a gamma-ray irradiation at a dose of 5×10^7 r. With increasing irradiation dose at low temperatures the anisotropy constant K_1 in ergs/cm³ was lowered in comparison with the unirradiated single crystal. At 77°K the value of K_1 was -3.5×10^4 for the unirradiated sample compared to -5.11×10^4 ergs/cm³ for the irradiated $NiFe_2O_4$ sample, and $+9.5 \times 10^4$ for the unirradiated sample compared to 5.9×10^4 ergs/cm³ for the irradiated $Ni_{0.75}Cu_{0.25}$ Fe_2O_4 sample. At 293°K the value of K_1 was -5.5×10^4 for the unirradiated $NiFe_2O_4$ compared to -6.12×10^4 ergs/cm³ for the irradiated $NiFe_2O_4$ sample, and -3.3×10^4 for the unirradiated $Ni_{0.75}Cu_{0.25}Fe_2O_4$ sample compared to -1.4×10^4 ergs/cm³ for the irradiated $Ni_{0.75}Cu_{0.25}Fe_2O_4$ sample. Values of the anisotropy constant for the $Ni_{0.5}Cu_{0.5}Fe_2O_4$ sample were 1.2×10^4 for the unirradiated sample compared to $+0.6 \times 10^4$ for the irradiated sample at 77°C, and -3.7×10^4 for the unirradiated sample compared to -2.3×10^4 for the irradiated sample at 293°K. (TTT)

29555 EFFECT OF REACTOR IRRADIATION ON THE ELECTRIC CONDUCTIVITY OF A TELLURIUM SINGLE CRYSTAL. Tuomi, T. O.; Berglung, P.; Gylling, R. (Technical Univ. of Helsinki). Phys. Lett., 26A: 581-2(May 6, 1968).

The electrical conductivity of tellurium has been found to increase linearly with increasing total fast neutron dose up to 2.5×10^{15} cm^{-2} during irradiation in a thermal reactor at 80°K. (auth)

29556 ELECTRON PROCESSES IN QUARTZ AS A RESULT OF IONIZING RADIATION. Potakhova, G. I.; Voevodin, V. G. (Siberian Inst. of Technical Physics, Novosibirsk, USSR). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 9, 149-52(1967). (In Russian).

In order to explain the electron traps in quartz and in order to study the electron distribution in these traps, the x-ray luminescence and thermal x-ray luminescence were measured on fused and monocrystalline quartz samples with a photomultiplier tube. The emission intensity depended on the irradiation intensity, but the luminescence from the fused quartz was greater than that from the monocrystalline quartz. During thermoluminescence the fused quartz showed a single wide maximum, which increased with increasing time of irradiation. The monocrystalline sample showed the presence of three maxima. Thirteen hours after irradiation the first maximum had disappeared, while maxima II and III still remained. The dielectric constants of the sample were related to the presence or absence of maximum I. Further study is necessary to establish the polarization mechanism of the trapped electrons and to determine the effect of structure on the change in dielectric characteristics of quartz during irradiation. (TTT)

29557 ENGASSING KINETICS OF METALS OF GROUP V A. III. INVESTIGATIONS IN THE SYSTEMS NIOBIUM–OXYGEN AND TANTALUM–OXYGEN. Hoerz, Gerhard (Max-Planck-Institut fuer Metallforschung, Stuttgart). Z. Metallk., 59: 283-8(Apr. 1968). (In German).

The kinetics of isotherm–isobar oxygen dissolution in niobium were investigated by stepwise and by continuous engassing at 1100 to 1800°C and pressures between 5×10^{-5} and 5×10^{-4} torr. The kinetics of isotherm–isobar oxygen dissolution in tantalum were investigated by stepwise engassing between 1100 and 2000°C and at 5×10^{-4} torr. The rate of the oxygen dissolution in niobium and tantalum is usually nearly independent of the oxygen concentration in the sample only at the beginning of the engassing. With increasing engassing time, the rate of oxygen uptake is decreasing. At the beginning of the engassing the ratio r of oxygen dissolution to oxygen transport to the sample surface at 1600°C is 0.63 in the system niobium–oxygen and 0.29 in the system tantalum–oxygen. Analysis of all data gives the result that at the beginning of the engassing in the system niobium–oxygen the engassing reaction is controlled by both the oxygen transport to the sample surface and by chemisorption, while in the system tantalum–oxygen the engassing reaction is actually only determined by chemisorption. The difference between activation energy of chemisorption and activation energy of desorption from physical adsorption state is 14.2 kcal/mole in the system niobium–oxygen and 11.3 kcal/mole in the system tantalum–oxygen. (auth)

29558 EPR STUDIES OF THE THERMAL DECAY OF THE OH RADICALS IN ELECTRON-IRRADIATED LITHIUM SULFATE AT 77°K. Aseltine, C. L.; Kim, Y. W. (Wayne State Univ., Detroit). Contract AT(11-1)-1054. J. Phys. Chem. Solids, 29: 531-9(Mar. 1968).

Single crystals of labeled lithium sulfate were grown with Li and H isotopes and irradiated in a 1-MeV electron beam at 77°K. After warming to room temperature and again returning to 77°K, the previously reported OH radical spectrum disappeared and two new types (B and C) of spectra were observed. The type-B spectrum can be described by an axially symmetric Hamiltonian containing a Zeeman term and an isotropic proton hyperfine interaction term. This spin Hamiltonian is assigned to a modification of the original OH radical, forming an O_2H radical. The type-C spectrum can be described by an axially symmetric Hamiltonian containing only a Zeeman term, and is attributed to an O_2^- radical produced simultaneously with the type-B center. (auth) (UK)

29559 FLOW STRESS OF TUNGSTEN IN THE PRESENCE OF A NONEQUILIBRIUM CONCENTRATION OF KINKS. Galligan, J. M. (Brookhaven National Lab., Upton, N. Y.). Phys. Lett., 26A: 550-1(Apr. 22, 1968).

A pulse heating experiment, designed to introduce a supersaturation of kinks, has been performed. No measurable decrease in the flow stress has been observed, as predicted if a Peierls–Nabarro stress is rate controlling. (auth)

29560 GAMMA- AND PHOTOLUMINESCENCE OF ALKALI IODIDES. Vasil'eva, N. N. Tr. Fiz. Inst., Akad. Nauk SSSR, 39: 219-68(1967). (In Russian).

Nonactivated luminescence of alkali metal iodides, γ- and photoexcitation, effects of impurities and crystal lattice disturbances on alkali iodide luminescence and time-duration characteristics of CsI(Tl) and KI(Tl) phosphors as functions of concentration are reviewed. Emission, excitation, and absorption spectra are given for KI(Tl), KI(In), RbI, CsI, RbI(In), RbI(Tl), CsI(Tl) and other alkali metal halide phosphors. The nature of ultraviolet band luminescence of pure alkali metal iodides and the mechanism of energy transfer from the basic material to the activator are analyzed. (144 references are included) (R.V.J.)

29561 INJECTION ELECTROLUMINESCENCE OF GALLIUM SELENIDE. Cingolani, A.; Levialdi, A. (Univ., Bari, Italy). Nuovo Cim., B, 55: 146-54(May 11, 1968).

Intrinsic electroluminescence that is produced by injecting electrons into GaSe was studied with the external electric field (a) perpendicular and (b) parallel to the c-axis. In case (a) one observes a red emission band (λ = 645 nm), probably due to transitions from the conduction band to a localized level; and a weak infrared band (λ = 1550 nm) which is attributed to intraband transitions. In case (b) one further observes two yellow emission exciton peaks and an intense band (λ = 601 nm) for which one observes a shift towards higher energy values with increasing current. The current dependence of the emitted light intensity and of the brightness wave is discussed. A superimposed radiation of energy equal to that of the absorption edge produces an enhancement effect. (auth)

29562 INTRODUCTION RATES OF ELECTRICALLY ACTIVE DEFECTS IN n- AND p-TYPE SILICON BY ELECTRON AND NEUTRON IRRADIATION. Stein, H. J. (Sandia Corp., Albuquerque, N. Mex.); Gereth, R. J. Appl. Phys., 39: 2890(May 1968).

Carrier-removal rates produced in n- and p-type silicon by 1.7 MeV-electron and reactor neutron irradiations were measured at 270°K on samples with resistivities between 0.1 and 50 Ω·cm. The measurements were performed under well-defined conditions on test samples selected from float-zone, quartz-crucible, Dash, and Lopex silicon crystals, and from epitaxial silicon slices. Most of the carrier-removal rates were determined from the initial 10% decrease in conductivity. Carrier-removal rates also were determined in heavily irradiated samples of float-zone and crucible-grown silicon. The electron-produced carrier-removed rate is strongly crystal growth dependent in n-type silicon, and the smallest removal rate is observed in quartz-crucible-grown material. The hole removal rate in p-type silicon under electron irradiation exhibits only weak crystal-growth dependence which becomes more pronounced during subsequent isochronal annealing. After 370°K annealing of both n- and p-type 10 Ω·cm materials, the smallest carrier-removal rate is observed in p-type Lopex silicon. Carrier-removal rates decrease with increasing electron fluence in both n- and p-type silicon. Neutron-produced carrier removal at 270°K is only weakly dependent upon crystal-growth method and conductivity type. Crystal-growth and conductivity-type dependence become significant, however, during subsequent isochronal annealing. After annealing to 370°K, the carrier removal remaining in n-type silicon is smallest for the crucible

grown material, and the hole removal remaining in p-type silicon is smallest for the Lopex material. Carrier-removal rates increase with increasing carrier concentration and decrease with increasing neutron fluence in both n- and p-type silicon. (auth)

29563 INVESTIGATION OF THE RESULTS OF (n,γ) REACTIONS IN TIN DIOXIDE BY THE METHOD OF NUCLEAR GAMMA RESONANCE. Babeshkin, A. M.; Pokholok, K. V.; Bekker, A. A.; Nesmeyanov, An. N. Radiokhimiya, 9: 668-73(1967). (In Russian).

The defects induced in tin dioxide crystals by (n,γ) reactions at 200 to 300 eV can be detected by means of nuclear γ resonance. The results obtained by this method indicate that the presence of supplementary peaks, detected in the irradiated dioxide samples, are caused by the formation of defects of different types in the irradiated crystals. (tr-auth)

29564 LINEAR STARK EFFECT OF THE F_3^+ CENTER IN LiF AND NaF. Johannson, G.; Lanzl, F.; von der Osten, W.; Piehl, R.; Waidelich, W. (Technische Hochschule, Darmstadt, Ger.). Phys. Lett., 26A: 629-30(May 6, 1968).

A linear Stark effect is observed with the ionized R center in γ-irradiated alkali metal halides by studying the zero-phonon absorption lines 4874 Å in LiF and 5456 Å in NaF in high electric fields. (auth)

29565 LOW-TEMPERATURE MAGNETIC PROPERTIES OF DYSPROSIUM SINGLE CRYSTALS. Jordan, R. G.; Lee, E. W. (Univ. of Sheffield, Eng.). Proc. Phys. Soc. (London), 92: 1074-82(Dec, 1967).

The magnetic properties of three single crystals of dysprosium were investigated along the principal directions of the hexagonal close-packed structure, over the temperature range 4° to 300°K and in applied fields up to 18 kOe. The measurements along the a and b directions agree in general with previous work. Along the c direction a small spontaneous moment was observed, appearing at (125 ± 2) °K, (89 ± 3) °K, and (88 ± 4) °K for the three crystals studied. The corresponding values of the spontaneous moment at 0°K are (1.9 ± 0.4), (2.7 ± 0.3), and (2.6 ± 0.3) emu g^{-1}. An analysis of the results indicates that the transition from antiferromagnetism to ferromagnetism is controlled by the strong dependence of the indirect exchange interaction with lattice dimensions. (auth) (UK)

29566 MAGNETIC SUSCEPTIBILITY AND THERMOPOWER DUE TO s–f ANOMALY IN Y–(Ce) DILUTE ALLOYS. Nagasawa, H.; Yoshida, S.; Sugawara, T. (Tokyo Univ. Roppongi, Tokyo). Phys. Lett., 26A: 561-2(Apr. 22, 1968).

The Kondo temperature of dilute Ce impurity in Y is determined to be 20 ~ 40°K from the temperature dependence of magnetic susceptibility and thermopower. (auth)

29567 MOESSBAUER STUDY OF PARAMAGNETIC RELAXATION IN DYSPROSIUM ETHYL SULFATE. Hufner, S.; Wickman, H. H.; Wagner, C. E. (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., 169: 247-51(May 10, 1968).

The Mössbauer effect of the 26.5-keV γ-ray transition of ^{161}Dy has been employed to study relaxation effects in dysprosium ethyl sulfate. The relaxation times determined from the Mössbauer spectra, while showing a typical exponential temperature dependence, were found to be faster than the corresponding rates extrapolated from the results obtained with "standard" relaxation-time measurements. Measurements employing oriented single crystals demonstrate "spin memory" of nuclear orientation during the relaxation processes: The selection rules $\Delta m_I = 0$ are verified for the Orbach relaxation processes. (auth)

29568 MOESSBAUER DIFFRACTION. I. QUANTUM THEORY OF GAMMA-RAY AND X-RAY OPTICS. Hannon, J. P.; Trammell, G. T. (Rice Univ., Houston, Tex.). Phys. Rev., 169: 315-29(May 10, 1968). (ORO-1316-49).

The Green-function techniques of quantum electrodynamics are used to obtain the equations governing the interaction of x rays and γ rays with crystals. In particular, the theory of Mössbauer γ ray optics for crystals containing the resonant nuclei is developed. (auth)

29569 NUCLEAR ELECTRIC-FIELD-GRADIENT DETERMINATION IN SINGLE CRYSTALS OF $Fe(NH_4SO_4)_2 \cdot 6H_2O$ AND $FeSO_4 \cdot 7H_2O$. Chandra, Kailash; Puri, S. P. (Univ. of Roorkee, India). Phys. Rev., 169: 272-6(May 10, 1968).

Single-crystal Mössbauer studies have been carried out on $Fe(NH_4SO_4)_2 \cdot 6H_2O$ and $FeSO_4 \cdot 7H_2O$ to determine the five independent parameters of the nuclear electric-field-gradient (EFG) tensor, viz., its principal values, asymmetry parameter, and coupling constant, and the direction cosines of the EFG axes with respect to the crystal axes. Furthermore, in view of the agreement of the observed and calculated values of the absorption-peak-area ratios, the anisotropy of the Lamb–Mössbauer fraction for both these cases does not appear to be significant. It is concluded that in the case of $Fe(NH_4SO_4)_2 \cdot 6H_2O$, the principal axes of the EFG tensor are not coincident with those of the susceptibility tensor. (auth)

29570 NUCLEAR MAGNETIC RESONANCE OF ^{195}Pt AND SATELLITE STRUCTURE IN Pt-RICH Pt–Mo ALLOYS. Weisman, I. D.; Knight, W. D. (Univ. of California, Berkeley). Phys. Rev., 169: 373-80(May 10, 1968).

An NMR investigation of ^{195}Pt in Pt-based alloys with Mo reveals the presence of satellites as well as large decreases in metallic shift versus Mo concentration. A "local" spin density with a relatively long range is thought to account for these phenomena. The results also suggest large reductions per Mo atom in the bulk susceptibility. One finds that the rigid-bank model seems not to explain the data, and a "distorted" band or a weakening of the exchange enhancement must instead be considered. In the Appendix, previously reported NMR results on Pt in Pt–Ir alloys are discussed in the light of some newly discovered contaminants. (auth)

29571 OBSERVATION OF ELECTRON HOPPING IN $^{151}Eu_3S_4$ BY MOESSBAUER SPECTROSCOPY. Berkooz, O.; Malamud, M.; Shtrikman, S. (Weizmann Inst. of Science, Rehovoth, Israel). Solid State Commun., 6: 185-8(Mar. 1968).

Mössbauer experiments between 77° and 500°K in $^{151}Eu_3S_4$ are reported. An electron-hopping model, together with an exchange-narrowing formula yield a temperature-dependent hopping time characteristic of an activation process. The activation energy found is 0.24 eV. Electrical conductivity measurements yield an activation energy of 0.22 eV. (auth) (UK)

29572 PHONON-ASSISTED OPTICAL ABSORPTION IN IRRADIATED MgO. Nakagawa, Masuo (Kyoto Univ.). J. Phys. Soc. Jap., 24: 1027-34(May 1968).

Color centers are introduced into MgO single crystals by reactor neutron irradiations. The energy separations obtained from several sharp peaks appearing on the longer wavelength tail of the 352- and 980-nm bands are in good agreement with characteristic phonon energies calculated by Karo and Hardy. The identifications of both 352 and 980 nm bands are considered, and it is suggested to assign the 352 nm band to the Cr ion centers associated with certain vacancies or defects and the 980 nm band to the M′ centers. (auth)

29573 PHOTOELECTRONIC EVALUATION OF ELECTRON RADIATION DAMAGE IN CdS CRYSTALS. Im, Ho Bin; Bube, Richard H. (Stanford Univ., Calif.). J. Appl. Phys., 39: 2908(May 1968).

The effects of electron radiation damage for electrons with energy between 75 keV and 2 MeV have been investigated in CdS single crystals by measurements of dark conductivity, photoconductivity vs temperature, spectral response of photoconductivity, optical quenching of photoconductivity, and thermally stimulated conductivity. The major effect of electron radiation damage is to decrease the electron lifetime in high-resistivity photosensitive crystals if the electron energy is 400 keV or higher. Relatively minor effects are also observed in dark conductivity, optical quenching, and thermally stimulated conductivity. Low-temperature annealing of irradiated crystals under illumination removes the effects of damage on the electron lifetime. After such annealing, however, all irradiated crystals exhibit a distinctly different trap distribution from nonirradiated crystals, prominent in which is the 289°K trap previously investigated and described as a repulsive trap in CDS and CdSSe crystals. (auth)

29574 PHOSPHOROUS-ION-IMPLANTED CdS. Anderson, W. W.; Mitchell, J. T. (Ohio State Univ., Columbus). Appl. Phys. Lett., 12: 334-6(May 15, 1968).

High-energy phosphorous ions implanted into CdS have given evidence of conductivity-type conversion after careful post-annealing. Thermal probe measurements consistently showed p-type conductivity on the implanted surface. Diodes fabricated from implanted material show good rectification characteristics, low voltage electroluminescence, and double-injection phenomena at room temperature. (auth)

29575 [111] PROTON CHANNELING IN VERY THIN GOLD CRYSTALS. Machlin, E. S. (Columbia Univ., New York); Petralia, S.; Desalvo, A.; Missiroli, G. F.; Zignani, F. Nuovo Cim., B, 55: 263-71(May 11, 1968).

An apparatus to carry out proton-channeling experiments on single-crystal films some hundreds of angstroms thick is described. The final aim of the work is the determination of the spatial distribution of the outer electrons, by measuring the energy loss when the proton incidence is parallel to the main crystallographic directions and for different emergence angles. (M.O.W.)

29576 PROTON-RADIATION-INDUCED BLISTERING OF ALUMINUM. Milacek, Leonard H. (Univ. of Oklahoma, Norman); Daniels, Raymond D.; Cooley, James A. J. Appl. Phys., 39: 2803-15(May 1968).

High-purity aluminum exhibited surface pitting and blistering when irradiated with protons in the 10 to 200 keV energy range. Pitting occurred during irradiation and is the predominant surface damage at lower proton energies. Blistering occurred at ambient temperature for samples irradiated at energies of 70 keV or lower. Samples irradiated at energies of 100 keV or higher exhibited a small amount of spontaneous blistering, but annealing above 200°C was necessary to produce large concentrations of blisters. Pitting and blistering phenomena were studied using optical and electron microscopy. Attention was given to the influence of surface preparation, material purity, microstructure, and cold work on the occurrence and appearance of blistering. These observations were correlated with radiation parameters to delineate the processes responsible for blistering. (auth)

29577 PULSED NUCLEAR MAGNETIC RESONANCE IN A TIN SINGLE CRYSTAL. McLachlan, L. A. (Univ. of British Columbia, Vancouver). Can. J. Phys., 46: 871-7(Apr. 1, 1968).

Pulsed nuclear magnetic resonance studies of an isotopically pure ^{118}Sn single crystal were made at 78°K. An attempt to observe anisotropy in the spin–lattice relaxation time was inconclusive, but gave $T_1T = (34 \pm 2)$ msec deg as the average value. Spin–spin relaxation was dominated by the pseudoexchange interaction. The numerical value for this, (2.0 ± 0.5) kc, is in agreement with the value calculated from the Rudermann–Kittel theory. A strong pseudodipolar interaction was also observed. (auth)

29578 QUANTUM STATISTICAL THEORY OF DYNAMIC POLARIZATION OF NUCLEI IN CASE OF HETEROGENEOUS BROADENING OF THE EPR LINES. Buishvili, L. L.; Zviadadze, M. D.; Kutsishvili, G. R. (Inst. of Physics, Tbilisi, USSR). Zh. Eksp. Teor. Fiz., 54: 876-90(Mar. 1968). (In Russian).

The quantum-statistical method is used to derive general equations describing the behavior of the electron–nuclear spin system of a crystal containing paramagnetic impurities under the action of variable magnetic fields. The EPR line is assumed to be ununiformly broadened and the dipole–dipole interaction of impurity electron spins is considered as a separate reservoir. On the basis of the general equations a study is made of the relaxation of the spin system and dynamical polarization of nuclei, taking into account spectral diffusion. (auth)

29579 RELATION BETWEEN THE g SHIFT AND HYPERFINE FIELD IN INTERMETALLIC COMPOUNDS. Davidov, D.; Shaltiel, D. (Hebrew Univ., Jerusalem). Phys. Rev., 169: 329-32 (May 10, 1968).

The appreciable variation of the gadolinium hyperfine fields from one compound to another in GdX_2 (X = Rh, Ir, Mn, Pt, Al) is explained by interaction of the nucleus with the conduction electrons. These electrons are polarized by their exchange interaction with the Gd ion. This interaction was investigated experimentally by measuring the Gd g shift by means of electron spin resonance. The g shift was found to vary in both magnitude and sign in these compounds. A relation between the Gd hyperfine field and the Gd g shift is derived, enabling us to calculate the hyperfine field per spin for 6s electrons in $GdPt_2$ to be 2.8×10^6 G. (auth)

29580 RELATION OF CRYSTALLINE AND MAGNETIC STRUCTURES IN HEAVY RARE EARTH METALS. Noskova, L. M. (Inst. of Physics of Metals, Moscow). Fiz. Metal. Metalloved., 25: 397-403(Mar. 1968). (In Russian).

An attempt was made to find a relation between the abnormal temperature behavior of Tb, Ho, and Dy crystal lattice parameters and their magnetic properties. It was noticed that in these rare earths the transition from ferromagnetic to spiral state takes place always with identical ratio of crystallographic axes $c/a = 1.580 \pm 0.001$. Considering the properties of the remainder J(O) – J(Q), it was assumed that independent from the type of the effective exchange integral and its Fourier properties, the temperature variations in the c/a ratio resulted in the shift of the sign of the above remainder. The latter is accompanied by the change of the type of the magnetic order and introduced an additional temperature relation in the expression for elementary excitation energy in the ordered magnetic moment systems of rare earth ferromagnetics. (R.V.J.)

29581 RESISTANCE AND TRANSVERSE MAGNETORESISTANCE OF HIGH PURITY ALUMINIUM. Stevenson, Richard (McGill Univ., Montreal). Can. J. Phys., 45: 4115-19(Dec. 1967).

Some data are given on the effects of purity and strain on the resistance and magnetoresistance of Al. Annealed Al wires of 59 (99.999%) and 69 (99.9999%) purity were used. The resistance ratios at 4.2°K were lower by a factor of 5 from that expected for unstrained samples; some self-annealing was observed. The ideal resistivity data fit the equation $\rho - \rho_0 = 7.5 \times 10^{-14}\ T^3 + 7.6 \times 10^{-17}\ T^5\ \Omega$-cm. Strains of 0.006 and 0.008 at 4.2°K had insignificant effect on the residual resistivity of the 69 purity, but the 0.008 strain increased that of the 59 purity by ~5%. The magnetoresistance was measured in fields up to 180 kOe. The resistivity rises rapidly to about 30 kOe, and then increases slowly and linearly with field. No strain effect was observed for the 59 purity, while the strained 69 purity showed a slightly larger magnetoresistance. The linear part of the magnetoresistance curves is 1.2×10^{-11} and 2.1×10^{-11} kOe-Ω-cm for 69 and 59 purities, respectively. (D.L.C.)

29582 ROLE OF FOCUSING COLLISIONS IN SPUTTERING. von Jan, R.; Nelson, R. S. (Atomic Energy Research Establishment, Harwell, Eng.). Phil. Mag., 17: 1017-32(May 1968). (AERE-R-5576).

A theoretical model, which considers the contribution to sputtering both from random ejections of surface atoms and from collision sequences initiated at different depths, provides a better understanding of the mechanism of sputtering from close-packed crystal directions, in particular, for high-energy sputtering. The model is based on a $(1/E^2)$ energy spectrum in the collision cascade, and also allows for thermal vibrations. The results show that focusing collisions must play a major part in producing the observed preferential ejection; the contribution of long-range collision sequences is not negligible and may dominate in materials with high focusing energies. Although the mean squared angular deviation of ejected atoms decreases markedly with increasing focusing energy, the average energy is not much affected. The influence of temperature on the total sputtering intensity and the energy spectrum is surprisingly weak even in those cases where long range sequences dominate. If focusing becomes strong enough to win against the unfavorable $(1/E^2)$ spectrum, it is also able to partly override the thermal defocusing. Application of results to other radiation damage processes is discussed. (auth)(UK)

29583 SCATTERING OF CHARGED PARTICLES IN A THIN MONOCRYSTAL. Kalashnikov, N. P.; Ryazanov, M. I.; Chukhovskii, F. N. (Moscow Engineering-Physics Inst.). Zh. Eksp. Teor. Fiz., 54: 822-5(Mar. 1968).

It is shown that in the scattering of fast charged particles in a thin monocrystal, the stream of particles regroup spatially. Corrections to the cross section of scattering of a fast electron in a crystal connected with the spatial regrouping of a particle stream are found. (auth)

29584 SCATTERING OF X RAYS ON A CRYSTAL IN WHICH THERE IS A TEMPERATURE GRADIENT, WITH THE THERMAL VIBRATIONS TAKEN INTO ACCOUNT. II. Bezirganyan, P. A. (Erevan State Univ., USSR). Zh. Tekh. Fiz., 37: 2218-23(Dec. 1967). (In Russian).

The author (Zh. Tekh. Fiz., 37: 1121(1967)) has previously calculated the effect of distortion of a crystal by the presence of a temperature gradient on the diffraction of x rays by the crystal. In the present paper these calculations are extended to take into account the effect of the thermal motions of the scattering centers. General formulas, involving sums over all the scattering centers, are derived for the intensities of the Laue diffraction peaks and the diffuse scattering. These formulas are discussed briefly for the two special cases when the temperature gradient is perpendicular or parallel to the scattering planes. In the case of a perpendicular temperature gradient the intensities of the Laue peaks are reduced; the reduction of the intensity of the Laue peaks is described by two factors, of which one is the usual Debye temperature factor and the other becomes more significant with decreasing temperature and increasing temperature gradient. A parallel temperature gradient reduces the intensities of the Laue peaks for a parallel incident beam, but in the case of a diverging incident beam under some conditions the parallel temperature gradient can increase the integral intensities of the Laue peaks. The temperature gradient gives rise to no new diffuse scattering maxima, but it increases their intensity and broadens them. (ATD)

29585 SELF-IRRADIATION DAMAGE IN THE ACTINIDE METALS. Griffin, C. S.; Mendelssohn, K.; Mortimer, M. J. (Clarendon Lab., Oxford). Cryogenics, 8: 110-11(Apr. 1968).

Further information has been obtained on the anomalous behavior of the low-temperature electrical resistivities of the actinide metals. Such behavior develops with increasing atomic number. It is suggested that the anomalous term in the resistivity is far more sensitive to self-irradiation than those due to scattering of electrons by impurities or lattice vibrations. (auth) (UK)

29586 SOME ROENTGENOPHYSICAL PROPERTIES OF SINGLE-CRYSTAL CdSe. Shirvaitis, A. I.; Alishauskas, A. V.;

Baubinas, R. V. (Kapsukas State Univ., Vilnyus, USSR). Liet. Fiz. Rinkinys, Liet. TSR Mokslu Akad., Liet. TSR Aukst. Mokyklos, 7: 463-73(1967). (In Russian).

The current–voltage, current vs x-ray dose characteristic, dependence of photocurrent on hardness of x rays and also the thermally stimulated current, when the traps were filled with visible light and x rays of single-crystal CdSe, which was grown by the method of Reynolds–Greene, were investigated. Energy required for one electron–hole pair and the recombination center cross section were calculated. The current–voltage characteristics are linear or superlinear, and current vs x-ray dose characteristics sublinear. The photocurrent depends on the hardness of x rays. The observed maximum of photocurrent moves to the side of the shorter wavelength, when thickness of single crystals increases. The energy of electron–hole pair is (4.2 to 4.8) eV and the recombination cross section is (10^{-16} to 10^{-18}) m^2. (auth)

29587 SPIN WAVES AND MAGNETIC RESONANCE IN RARE-EARTH METALS: THERMAL, APPLIED-FIELD, AND MAGNETOELASTIC EFFECTS. Cooper, Bernard R. (General Electric Research and Development Center, Schenectady, N. Y.). Phys. Rev., 169: 281-94(May 10, 1968).

The theory is developed for the temperature and magnetic-field dependence expected for the energy of long-wavelength spin waves in ferromagnetic heavy rare-earth metals. Emphasis is placed on examining magnetoelastic effects on the spin-wave energies. The resulting theory is applied to understanding recent neutron inelastic-scattering and ferromagnetic-resonance experiments in Tb and Dy. For Tb and Dy, comparison of theoretical predictions with the experimental results, especially the magnetic field dependence of the uniform-mode spin-wave energy, precludes the applicability of the frozen-lattice approximation suggested by Turov and Shavrov for magnetoelastic effects on spin-wave energies. The most striking point found is the contrast between the behavior of Tb and that of Dy. For Tb, the magnitude of the planar anisotropy constant found in static measurements is much smaller than the value necessary for agreement with the spin-wave experiments, i.e., neutron inelastic scattering and ferromagnetic resonance, which are mutually consistent. In contrast to this puzzling discrepancy for Tb, for Dy the static measured planar anisotropy constant gives absolute calculated values for the spin-wave behavior in excellent agreement with the results of ferromagnetic-resonance experiments. (auth)

29588 STUDY OF THE EFFECT OF ACCELERATED ELECTRONS ON THE STRUCTURE OF POLYCRYSTALLINE BARIUM TITANATE. Ismailzade, I. G.; Azizov, T. S.; Nesterenko, V. I.; Shamilzade, Z. M. Izv. Akad. Nauk Azerb. SSR, Ser. Fiz.-Tekh. Mat. Nauk, No. 3, 68-70(1966). (In Russian).

Although the effect of γ and neutron radiations on the dielectric properties of ceramic barium titanate have been studied, the action of accelerated electrons on polycrystalline materials have not yet been investigated. Therefore such a study was undertaken, using the electron beam of the linear accelerator of the Azerbaijan Radiation Physics Laboratory and 3-mm-thick and 10-mm-diameter barium titanate discs of a barium titanate, prepared from stoichiometric mixtures of $BaCO_3 + TiO_2$, preheated at about 900°C and soaked for 1 hour at 1250°C. The structural changes were followed by an x-ray-diffraction apparatus. The unit cell constants were calculated from the 002 and 200 maxima. After exposure to 4-MeV electrons at a flux of 3.6×10^{14} particles/second for 5 minutes under cooling with dry ice, the yellow material became grayish; the intensity of the 022 and 200 maxima was increased and their position was slightly changed. The electron bombardment caused an increase in the spontaneous deformation of the lattice, resulting in an increase of the Curie temperature. Heating of the irradiated specimen to 350°C for 15 to 20 minutes caused the disappearance of the gray color and the yellow shade; the original unit cell dimensions were also regenerated. This might be due to changes in the charge of the Ba^{2+}, Ti^{4+}, and O^{2-} ions, caused by the ionization of the atoms and electron capture. (TTT)

29589 THEORY OF NUCLEAR MAGNETIC TRIPLE RESONANCE SPECTRA IN THE CASE OF WEAK RADIO-FREQUENCY FIELDS. II. Sinivee, V.; Salum, V. (Inst. of Cybernetics, Tallin, USSR). Izv. Akad. Nauk Est. SSR, Fiz. Mat., 17: 49-64 (1968). (In Russian).

A detailed analysis of line shapes expected for the weak rf field region of nuclear magnetic triple resonance spectra is given. (auth)

29590 X-RAY K-ABSORPTION EDGE OF YTTRIUM IN SOME YTTRIUM COMPOUNDS. Bhide, V. G.; Bhat, N. V. (National Physical Lab., New Delhi). J. Chem. Phys., 48: 3103-8(Apr. 1, 1968).

The x-ray K-absorption edge position and the extended structure of yttrium in several compounds have been investigated using 400-mm bent-crystal (mica) spectrograph. The absorption edge on and the extended structure for Y^{3+} in dilute aqueous solutions of several salts have been found to be identical indicating that Y^{3+} ions absorb as if they are in vacuum. The absorption edge position for the Y^{3+} ion in a solution has been taken as a reference with which the edge position for Y^{3+} ions in different compounds is compared. The shift of the absorption edge towards the lower-frequency side seems to be related to the covalency. If the near neighbors are unchanged, a change in the distant neighbors does not affect the absorption edge position appreciably. (auth)

29591 ION BURIAL AND THERMAL REEMISSION AT NICKEL SURFACES. Truhlar, John Francis. Pullman, Wash., Washington State Univ., 1967. 67p.

Thesis.

The trapping and thermal reemission of 100 to 300 eV Ar^+ and Kr^+ ions at a polycrystalline nickel target were studied. For Ar^+ and Kr^+ the trapping probabilities are, respectively, 0.020 and 0.015 at 100 eV and 0.46 and 0.33 at 300 eV. Thermal reemission after trapping reveals peaks in the reemission spectrum with corresponding activation energies of 1.18, 1.36, 1.53, 1.72, 1.89, and 2.20 eV. The lowest three energies are believed to be, respectively, correlated with interstitial migration, vacancy formation, and vacancy migration near the surface. The highest energy may be due to surface recrystallization from dislocations produced by the ion bombardment. The intermediate energies probably correspond to the motion of nickel surface atoms along the ridges of facets formed during the bombardment. The measured activation energies for the release of gas atoms correspond to activation energies which are determined by others for the removal of defects resulting from radiation damage or cold working of nickel. Peaks in the krypton spectrum occur at the same temperatures as do the peaks in the argon spectrum confirming the idea that the substrate plays a more important role in determining the site distribution and release mechanism than does the bombarding gas. (Diss. Abstr.)

29592 MAGNETIC SUSCEPTIBILITY AND KNIGHT SHIFT MEASUREMENTS IN ALUMINUM–RARE EARTH ALLOYS. Stupian, Gary Wendell. Urbana, Ill., Univ. of Illinois, 1967. 132p.

Thesis.

Measurements of magnetic susceptibility and solvent Knight shift in dilute alloys of rare earth metals in aluminum were carried out. The susceptibility results give a clear indication that localized moments exist on each impurity except La, Yb, and Lu, and that the coupling between the total spin and the total orbital angular momentum of f electrons is dominant in determining the size of localized moments on solutes. The maximum magnitude of localized moments observed was over $10\mu_B$, which is impossible without a contribution to the magnetic moment from orbital angular momentum. The susceptibility also shows the deviation from Curie law behavior resulting from the population of excited states. The solvent Knight shift has permitted a particularly penetrating investigation of solute structure because it is influenced only by the polarization of electron spins. The observations show conclusively that the spin magnetization opposes the total impurity magnetization in lighter rare earths while aiding it in heavier rare earths. A quantitative discussion, using scattering theory, of the electron polarization caused by magnetic impurities has been found to give a satisfactory account of observed Knight shift changes. The magnitude and sense of the shifts are reproduced satisfactorily by the assumptions that the localized states are about 0.6 eV wide and that, for heavier elements containing electrons in both spin-up and spin-down subbands, these sub-bands are separated by about 1 eV. A qualitative explanation of the observed NMR solvent line width for the various solutes has also been offered. (Disser. Abstr.)

29593 ULTRASONIC ATTENUATION STUDIES IN POTASSIUM AND BERYLLIUM. Hoffman, Allan Richard. Providence, Brown Univ., 1967. 122p.

Thesis.

Overhauser's suggestion that potassium is not a free electron metal, but is a metal whose ground state is a finite amplitude spin density wave state, has not met with universal acceptance. The determination of absorption edges in the ultrasonic attenuation associated with Doppler-shifted cyclotron resonance of longitudinal sound waves, propagated at oblique angles to a dc magnetic field, is capable, in principle, of distinguishing between the two models. Studies of such edges in potassium, as well as studies of the general features of the attenuation for oblique propagation, have been carried out. Data for three different samples were obtained at liquid helium temperatures, for acoustic frequencies ranging to 140 Mc. The most extensive set of data was analyzed for comparison with theory. The results, although suggestive of the free electron model in some cases, were not definitive. Suggestions for a more definitive experiment are offered. Geometric resonance extrema observed at oblique angles were found to be associated with nonexternal orbits on the Fermi surface. Ultra-

sonic studies in beryllium at liquid helium temperatures have been conducted in magnetic fields up to 80 kG and frequencies to 780 Mc. At fields below a few kilogauss, the attenuation is believed to exhibit geometric resonance oscillations associated with both hole and electron orbits. At fields above 4 kG, the attenuation exhibits quantum oscillations associated with a variation of the density of states at the Fermi surface. The first quantum structure to appear is a strong difference frequency oscillation associated with the hip and waist orbits of the electron cigars. At still higher fields a beat pattern, associated with these same orbits, appears, superimposed on the difference frequency oscillations. This combined pattern persisted to the highest fields attained in the experiments. The observed high field results are in accord with the results of magnetothermal measurements in beryllium, and with thermodynamic predictions. Evidence of a direct interaction between the sound field and beryllium's conjectured domain structure was not observed. Distortion of the ultrasonic waveforms, associated with strong magnetic interaction in beryllium, was observed at the highest fields and the lowest temperatures. (Disser. Abstr.)

29594 ACCUMULATION OF COLOR CENTERS IN ZnS MONOCRYSTALS DUE TO FAST NEUTRON ACTION. Putiev, I. T.; Gavrilov, F. F.; Shasharin, G. A. (Ural Polytechnic Inst., Sverdiovsk, USSR). Fiz. Tekh. Poluprov., 2: 53-5(Jan. 1968). (In Russian).

Results of an experimental investigation of the effects of fast-neutron irradiation on the optical absorption spectra of monocrystals of ZnS are reported. Absorption bands of color centers were detected in the 375-nm region. The optical concentration of the color centers during irradiation with doses from 10^{14} to 10^{18} n/cm^2 was determined. The results are compared with calculated data on the dependence of the number of displacements on the irradiation dose. (tr-auth)

Theoretical Physics

Refer also to abstract 30104.

29595 (UCRL-50377) ONE-PARTICLE DENSITY MATRIX FOR HARD-SPHERE BOSONS AT ZERO TEMPERATURE. Garrison, J. C.; Wong, J. (California Univ., Livermore. Lawrence Radiation Lab.). Jan. 17, 1968. Contract W-7405-eng-48. 49p. Dep. CFSTI.

A calculation, using the binary kernel expansion developed by Lee and Yang, of the one-particle density matrix for a system of hard-sphere bosons at zero temperature is presented. The Fourier transform of the density matrix exhibits a delta function behavior at zero momentum; the coefficient is evaluated as an expansion up to first order in the small parameter $(\rho a^3)^{\frac{1}{2}}$, where ρ is the density and a is the hard sphere radius. The form of the Fourier transform for nonzero values of the momentum is also obtained. From these results the fraction of particles in the condensed (zero-momentum) mode is calculated. The results are in agreement with those of Lee, Huang, and Yang obtained by using the pseudo-potential method. (auth)

29596 CLUSTER EXPANSIONS IN MANY-FERMION THEORY. II. REARRANGEMENTS OF PRIMITIVE DECOMPOSITION EQUATIONS. Westhaus, Paul (Univ. of Wisconsin, Madison); Clark, John W. J. Math. Phys. (N. Y.), 9: 149-54(Jan. 1968).

The "factor-cluster" formalisms introduced in the preceding paper are used as a tool for a further development of the cluster theories proposed by Iwamoto and Yamada and by Aviles, Hartogh, and Tolhoek. The primitive decomposition characterizing each of the older formalisms is rearranged into the exponential of a series with a uniform N dependence in the limit of large N. In addition a "linked cluster" theorem is proven for the series comprising the exponent in the Iwamoto–Yamada formalism. Our derivations, unlike those of earlier authors, are valid for all N. (auth)

29597 DISPERSION-FREE NORMAL STATES. Plymen, R. J. (Oxford Univ.). Nuovo Cim., 54A: 862-70(Apr. 21, 1968).

A structure theorem is given for W*-algebras which admit dispersion-free normal states. This theorem is a generalization of von Neumann's classical theorem that dispersion-free density matrices do not exist in quantum mechanics. (auth)

29598 ELEMENTARY SOLUTIONS OF THE QUANTUM PROBLEM OF THE MOTION OF A PARTICLE IN THE FIELD OF TWO COULOMB CENTERS. Demkov, Yu. N. (Leningrad State Univ.). JETP Lett., (USSR) (Engl. Transl.), 7: 76-9(1968).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 7: 101-4(Feb. 5, 1968).

Simple analytic solutions are presented for some particular cases of the problem of the bound states of a particle in the field of two Coulomb centers. (A.G.W.)

29599 EULERIAN DIFFERENCING METHOD FOR UNSTEADY COMPRESSIBLE FLOW PROBLEMS. Gentry, Richard A.; Martin, Robert E.; Daly, Bart J. (Los Alamos Scientific Lab., N. Mex.). Contract W-7405-eng-36. J. Comput. Phys., 1: 87-118(Aug. 1966). (LA-DC-7672).

An Eulerian finite difference method is presented which can be used with a high-speed computer to solve the time-dependent equations of motion for the compressible flow of a fluid. The difference equations are described in detail, and the nature of the truncation errors introduced by the numerical approximations is discussed, as are the stability properties of the equations. Three solutions involving time-dependent flow in two space dimensions are described and analyzed: the diffraction of a weak shock traveling through a z-shaped tunnel, the interaction of a supersonic blunt body with a plane shock wave, and the passage of a plane shock over a conical body. Good agreement with experimental data is obtained in all cases where comparisons are made. (auth)

29600 EVALUATION OF FERMI AND BOSE INTEGRALS. Swenson, R. J. (Temple Univ., Philadelphia). Phys. Lett., 26A: 632-3(May 6, 1968).

Integral representations for the Fermi and Bose functions are given and the simplifications resulting in the evaluation of Fermi and Bose integrals are discussed. (auth)

29601 FURTHER GENERALIZED BOSE CONDENSATION, ANISOTROPIC ODLRO AND THIN ^{4}He FILMS. Carmi, Gideon (Yeshiva Univ., New York). J. Math. Phys. (N. Y.), 9: 174-80 (Jan. 1968).

A detailed analysis is presented of the Bose condensation of an ideal Bose gas, finite in one dimension and infinite in the other two. Limiting processes, which were treated questionably in previous work, are here re-examined, and some seemingly paradoxical conclusions of the past work are explained. Two new concepts emerge — those of "further generalized Bose condensation" (FGBC) and "anisotropic off-diagonal long-range order" (AODLRO). The two concepts are shown to be connected to each other, and both are shown to exist at T = 0 for the model discussed. (auth)

29602 GENERALIZED UNCERTAINTY RELATIONS FOR MANY-FERMION SYSTEMS. Levy-Leblond, J. M. (Faculte des Sciences, Nice). Phys. Lett., 26A: 540-1(Apr. 22, 1968).

Diagonalizing the Hamiltonian for N identical fermions interacting via two-body harmonic forces, one obtains generalized uncertainty relations, thereby giving a rigorous foundation to the usual heuristic interpretation of the Pauli principle. (auth)

29603 GEOMETRICAL AND TENSORIAL LORENTZ TRANSFORMATIONS. Pytte, A.; Balescu, R. (Univ., Brussels). Nuovo Cim., B, 55: 51-75(May 11, 1968).

Geometrical functions are defined as macroscopic quantities whose Lorentz transformation law is independent of the underlying molecular dynamical law. Tensors are particular cases of such quantities. Pregeometrical functions and pretensors are defined as microscopic dynamical functions whose averages are, respectively, geometrical quantities or tensors. A first step is made towards a systematic search of criteria to be obeyed by an arbitrary dynamical function of a relativistic plasma in order to have a pregeometrical or a pretensorial character. All possible types of pregeometric functions and of pretensors are determined, depending either on particle variables alone or on field variables alone. Moreover, composition rules are established which generate additional cases of pretensors, depending on both particle and field variables. (auth)

29604 INTENSITY-DEPENDENT FREQUENCY SHIFT IN SCATTERING OF ELECTROMAGNETIC WAVES BY FREE ELECTRONS. PART I. CLASSICAL THEORY. Prakash, Hari; Vachaspati (Univ. of Allahabad, India). Indian J. Pure Appl. Phys., 5: 532-4(Nov. 1967).

Scattering of electromagnetic wave in which the amplitude of the vector potential is a step function of the phase, by a free electron, is studied. When this wave falls on the electron, the latter acquires, for the duration of the pulse, an extra average velocity proportional to incident intensity. This leads to an intensity-dependent frequency shift which agrees with the results reported in literature. When the pulse of radiation is switched off, the electron loses the extra average velocity which is acquired on switching on of the radiation. Thus the net effect of switching on and off of the pulse is that finally the electron has the same velocity as it had initially. Therefore, if a number of pulses fall on the electron in succession, they do not each enhance the velocity of the electron; on the other hand, their effect is just

the same as if only one pulse had fallen on the electron. Thus, the frequency shift for several successive pulses is the same as that for one pulse. (auth)

29605 MOTION OF OPPOSITELY CHARGED PARTICLES IN A MAGNETIC FIELD. Sveshnikov, A. G.; Volosov, V. M.; Glasko, V. B.; Semashko, N. N. (Moscow State Univ.). Zh. Tekh. Fiz., 37: 2137-46(Dec. 1967). (In Russian).

The nonrelativistic motion perpendicular to a uniform magnetic field of small groups of charged particles is studied taking into account the Coulomb forces between the particles. The calculations were undertaken because of their interest in connection with injection of plasma into magnetic traps. Most of the paper is devoted to a rather detailed discussion, based on analytic calculations and numerical computations, of the motion of two particles, either having like charges and equal masses or having opposite charges and greatly differing masses. It is found that when the magnetic forces are sufficiently strong compared with the Coulomb forces there takes place a stable drift of the two oppositely charged particles transversely to the magnetic field. The equations of motion for 5 ions and 5 electrons in a uniform magnetic field were solved numerically for certain values of the relevant parameters, and the results are discussed. Certain features of the motion of two oppositely charged particles persist in the motion of the groups of 5 particles. It was found that the character of the drift is determined mainly by the interaction of the groups of oppositely charged particles, the Coulomb repulsion between the particles of the same group playing a secondary role. It was also found that there is a tendency for the beam to contract somewhat if the Coulomb forces are not too weak compared with the magnetic forces. (ATD)

29606 ON THE BOGOLYUBOV APPROXIMATION FOR MANY BOSON SYSTEMS. Ginibre, J.; Velo, G. (New York Univ., N. Y.). Phys. Lett., 26A: 517-8(Apr. 22, 1968).

The infinite volume limit of the pressure of a many-boson system, in the Bogolyubov approximation, for fixed $\langle a_0 \rangle / \sqrt{V} = \xi$, exists and is a concave function of ξ. Consequences for Bose–Einstein condensation are discussed. (auth)

29607 RIGOROUS WAVE FUNCTION FOR SPIN-½ COMPOSITE PARTICLES. Rosen, Gerald (Drexel Inst. of Tech., Philadelphia). Can. J. Phys., 46: 909(Apr. 1, 1968).

A certain composite four-index quantity built up from three constituent spinor wave-function solutions to the Dirac equation is shown to transform as a spinor and to satisfy the Dirac equation. This rigorous wave function is therefore associated with a composite relativistic spin-½ particle. (auth)

29608 SCHROEDINGER EQUATION FOR THE INTERACTION WITH EXCHANGES. Vanagas, V. V.; Petrauskas, A. K. (Inst. of Physics and Mathematics, Vilnyus, USSR). Liet. Fiz. Rinkinys, Liet. TSR Mokslu Akad., Liet. TSR Aukst. Mokyklos, 7: 269-77 (1967). (In Russian).

The general Schroedinger equation for the Hamiltonian with exchanges is presented. This equation is discussed in detail in case of three one-dimensional oscillators. The obtained system of partial differential equations is reduced to the ordinary equations. It appears, that the solutions of these equations include both one-particle and collective type solutions. (auth)

29609 THEORY OF QUANTUM-MECHANICAL DESCRIPTION. Elsasser, Walter M. (Univ. of Maryland, College Park). Proc. Nat. Acad. Sci. U. S., 59: 738-44(Mar. 1968).

In a recent book, Brillouin has gathered a great many illustrative examples to show how, in problems of classical physics, any initial uncertainty increases with time. His work is clearly related to the fact that since the advent of quantum mechanics there have been the two schools of thought: those who tried to return toward classical determinism and those who found in quantum theory a challenge for investigating all possible ramifications or generalizations of indeterminacy which may be part of physical description and prediction. This note belongs to the second category, as does Brillouin's work. (W.D.M.)

29610 TIME EVOLUTION OF A SYSTEM WITH A STOCHASTIC HAMILTONIAN. Czajkowski, G. Z. (Copernicus Univ., Torun, Poland). Bull. Acad. Pol. Sci., Ser. Sci. Math. Astron. Phys., 16: 131-6(1968).

Recently many papers have appeared in the literature studying the systems with a stochastic Hamiltonian. Two types of assumptions are usually made: (i) Some of the Hamiltonian symmetries or some statistical moments of its matrix elements are known. (The Hamiltonian in this case is assumed as time independent.) (ii) some exterior parameters are changed stochastically (here the Hamiltonian has a certain time dependent, stochastic part). In the present note only case (i) is considered. Starting from the von Neumann equation $i\,[\partial\rho(t)/\partial t] = H,\rho(t)$, the time evolution of systems with a stochastic Hamiltonian are dealt with. (W.D.M.)

29611 THEORY OF ORBITS. THE RESTRICTED PROBLEM OF THREE BODIES. Szebehely, Victor. New York, Academic Press Inc., 1967. 681p. $25.00; 200s.

This book offers a comprehensive picture of this gravitational problem of astronomy and astrodynamics. The qualitative, quantitative, and formalistic approaches to Newtonian, Lagrangian, and Hamiltonian dynamics are presented. The contributions of Euler, Poincaré, Birkoff, Strömgren, Wintner, and many others are included. Special emphasis is placed on recent applications of the method of regularization to lunar and interplanetary trajectories. Other topics include periodic orbits, stability, Kolmogorov's theorem, numerical results, libration-point problems, curves of zero velocity, canonical transformations in the extended phase space, stream-line analogy, etc. Several applications in astronomy, astro-dynamics, cosmology, and space research are given. (W.D.M.)

29612 CLUSTER EXPANSIONS IN MANY-FERMION THEORY. I. "FACTOR-CLUSTER" FORMALISMS. Clark, John W. (Washington Univ., St. Louis); Westhaus, Paul J. Math. Phys. (N. Y.), 9: 131-48(Jan. 1968).

Cluster development may furnish a powerful device for the calculation of the expectation values of the observables of a many-fermion system with respect to dynamically correlated state vectors. The generalized normalization integral, a generating function for the required expectation values, is defined, and four of the many possible decompositions of this function into cluster integrals are explored. Two of these decompositions are slight extensions of the conventional ones of Iwamoto and Yamada and Aviles, Hartogh, and Tolhoek. The other two are product decompositions, leading to new "factor-cluster" formalisms. A factor-cluster expansion is applied to the evaluation of the n-particle spatial distribution function. (auth)

PHYSICS (HIGH ENERGY)

Particle Interactions and Properties (Experimental)

29613 EXPERIMENTAL PROGRAMME AT THE PROTON SYNCHROTRON. CERN Cour., 8: 71-6(Apr. 1968).

A review of the current program at the CERN 28-GeV proton synchrotron is presented. The available beams, electronics experiments, and bubble chamber experiments are discussed. (W.H.K.)

Electromagnetic

29614 (DESY-68/14) QUASIELASTIC ELECTRON-DEUTERON SCATTERING BETWEEN $q^2 = 18$ f^{-2} AND 100 f^{-2}. Albrecht, W.; Behrend, H.-J.; Dorner, H.; Flauger, W.; Hultschig, H. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Mar. 1968. 11p. Dep.

Quasi-elastic e-d scattering measurements were performed up to $q^2 = 100$ f^{-2}. Only the electron was detected. The ratio $R = (d^2\sigma/d\Omega dE')_{ed}/(d\sigma/d\Omega)_{ep}$ was measured at the quasi-elastic peak; the magnetic form factor G_M^N of the neutron was deduced using the assumption $G_E^N = 0$. (auth)

29615 MEASUREMENT OF THE ANGULAR DEPENDENCE OF THE POLARIZATION OF THE RECOIL PROTONS FROM THE PHOTOPRODUCTION OF NEUTRAL PIONS ON HYDROGEN AT PHOTON ENERGIES BETWEEN 240 AND 420 MeV. Althoff, K. H.; Finken, D.; Minatti, N.; Piel, H.; Trines, D.; Unger, M. (Univ., Bonn). Phys. Lett., 26B: 677-8(Apr. 29, 1968).

New measurements of the polarization of the recoil protons from the reaction $\gamma + p \rightarrow \pi^0 + p$ are reported for the region of the first resonance. These measurements are an extension of earlier experiments, done on the 500 MeV-electron-synchrotron. More data have been taken at photon energies of 240, 300, 360 and 420 MeV. (auth)

29616 POSITIVE-PION PHOTOPRODUCTION BY LINEARLY POLARIZED γ RAYS. I. EXPERIMENTAL METHOD AND RESULTS. Grilli, M. (CNEN, Rome); Spillantini, P.; Soro, F.; Nigro, M.; Schiavuta, E.; Valente, V. Nuovo Cim., 54A: 877-96 (Apr. 21, 1968).

The appatatus and the experimental method used for the measurements of the single-π^+ photoproduction by linearly polarized γ rays are described. The present results on the asymmetry ratio $A(\theta)$ are summarized. The range covered by our results is θ = (30 to 145)° (c.m.) and E_λ = (200 to 450) MeV. (auth)

29617 PROTON COMPTON EFFECT. Rust, David Reuel. Ithaca, N. Y., Cornell Univ., 1967. 88p.

Thesis.

A review of previous experiments which investigate the proton Compton effect (elastic photon-proton scattering) is given and a few attempts at theoretical descriptions of the process are briefly described. The experiment on which the thesis is based is then described in detail. Measurements of the differential cross section at 90° in the cms system for photon-proton scattering were made over a range of incident photon energies from 450 to 1400 MeV. Spark chambers and counters were used to detect the outgoing proton and photon and the spark chamber photographs were analyzed using a special automatic scanning and measuring device. The results extend previous investigations to higher energies and show a remarkable dip in the cross section above the energy corresponding to the third nucleon isobar. (Disser. Abstr.)

29618 PION PRODUCTION BY POLARIZED VIRTUAL PHOTONS. Akerlof, Carl William. Ithaca, N. Y., Cornell Univ., 1967. 95p.

Thesis.

The reaction $e + p \rightarrow e + n + \pi^+$ was studied by detecting electrons scattered from a liquid hydrogen target in coincidence with a charged pion. The experiment was performed using the internal circulating beam of the Cornell 2.2 GeV electron synchrotron with the hydrogen target inside the synchrotron vacuum system. The experiment was designed to measure the azimuthal variation of the electroproduction cross section around the virtual photon direction. Measurements were taken for photon 4-momentum transfers of -1.0 Fermi^{-2} and -3.5 Fermi^{-2} and for pion-nucleon energies in the region of the N*(1236) resonance. By use of the one-photon-exchange model the electroproduction cross sections reduced to a form equivalent to a photoproduction cross section. The azimuthal variation of these numbers was used to separate the cross section into two terms, σ_U and σ_p. The values for σ_U and σ_p were found to be in reasonable agreement with theoretical dispersion relation calculations. The negative values obtained for σ_p confirmed the positive parity assignment for the N*(1236) and suggest that the high polarization of the virtual photon may be of use in determining the parities of the higher resonances. (Disser. Abstr.)

29619 BACKWARD DEUTERON ELECTRODISINTEGRATION AT SMALL MOMENTUM TRANSFERS. Napolitano, E. (Univ., Turin); Reineri, M. T.; Ponzano, G. Nuovo Cim., B, 55: 107-45(May 11, 1968).

Nonrelativistic amplitudes are used to study the deuteron electrodisintegration at very low momentum transfers ($Q^2 < 0.5$ fm^{-2}) when $\vartheta = 180°$. The effects of tensorial forces, of an infinitely repulsive core and of different types of approximate radial wave functions are studied. The inclusion of transversal electric transitions leads to important effects in the tail region of the final electron spectrum. In particular, the proton polarization in coincidence with the final electron turns out to be very sensitive to the details of M1 spin-flip radial integrals. (auth)

Weak

29620 COMPARISON OF THE μ^+- AND μ^--DECAY SPECTRA IN COPPER. Beilin, P. B. (Univ. of California, Berkeley). Nuovo Cim., 54A: 871-6(Apr. 21, 1968). (UCRL-16168(Rev.)).

The momentum spectrum of electrons from the decay of muons brought to rest in copper was measured using an Elbek-type magnetic spectrometer with scintillation counters on the focal plane. For comparison, the spectrum from positive muons was also measured. Good agreement is obtained between the spectrum from unbound muons (μ^+) and theoretical predictions. The experimental bound-muon-decay spectrum shows less satisfactory agreement, the data favoring a faster fall-off with momentum at the upper end of the spectrum than is theoretically predicted. (auth)

Strong (Baryon-Induced)

29621 INELASTIC SCATTERING OF 20 GeV PROTONS IN G-5 EMULSION. Lee, Yung Jae; Suh, Il Hwan. J. Nucl. Sci. (Seoul), 7: 32-41(Oct. 1967).

Absorption mean free paths of 20 GeV protons are measured in G-5 emulsion and are found to be (34.7 ± 1.6) cm when hydrogen atoms are included as target nucleus meanwhile (35.9 ± 1.7) cm when the hydrogen atoms are assumed to be excluded from the target. The corresponding values of the elementary cross section, which are found graphically, are $(32.3^{+\frac{1}{1.5}}_{-\frac{2}{1.5}})$ mb and $(33.5^{+\frac{1}{1.5}}_{-\frac{2}{1.5}})$ mb respectively. The average absorption cross sections, corresponding to the elementary cross sections are 365.5 mb and 594.5 mb respectively. The absorption cross sections are also calculated by the Williams empirical formula and are found to be 364.1 mb and 591.4 mb which are pretty close to the observed values. (auth)

29622 INELASTICITY OF COSMIC-RAY JETS OF 10^{15}eV. Imaeda, K.; Kazuno, M.; Fleming, P. (Inst. for Advanced Studies, Dublin). Nuovo Cim., B, 55: 288-91(May 11, 1968).

An interaction O+ 14_p ($E_{prim} \simeq 10^{15}$ eV) which occurred at 2.3 cm from the top of the ICEF stack is investigated. The inelasticity of the event seems unusually small, of the order of 0.01. The possible mechanism of such an interaction of small multiplicity is discussed. The event is most likely a nucleon–nucleon collision because it has no heavy prongs, an even number of charged secondaries, and no Auger electron at the point of interaction. From six independent measurements, the angular distribution of the secondary particles was obtained and the result is shown. The primary energy was estimated by the Castagnoli method to be 1.2 $(10)^{15}$ eV ($\gamma_c = 818$). The energy of the electromagnetic cascades is 1.7 $(10)^{12}$ eV, and the total energy transferred to all the secondary particles observed was approximately 5$(10)^{12}$ eV. (J.F.P.)

29623 SMALL ANGLE pp SCATTERING IN THE MOMENTUM RANGE 1.3 TO 1.5 GeV/c. Dutton, L. M. C.; Van Der Raay, H. B. (Univ. of Birmingham, Eng.). Phys. Lett., 26B: 679-81(Apr. 29, 1968).

Elastic pp scattering in the Coulomb interference region was studied using sonic spark chambers with a magnetic spectrometer. Measurements were made at 1.29, 1.39 and 1.54 GeV/c and the data were analysed to determine the real part of the spin independent forward scattering amplitude. Disagreement with the predictions of dispersion relation calculations was found. (auth)

29624 COMPUTATION OF TRANSMISSION OF 28 GeV PROTONS IN EMULSION MEASURED BY ALONG-THE-TRACK SCANNING METHOD. Lee, Yung Jae. J. Nucl. Sci. (Seoul), 7: 27-31(Oct. 1967).

An attempt of computing the total cross section of emulsion for the high-energy protons is made in combination of the along-the-track scanning method with track counting method which is originally related with the along-the-track method. The total cross section obtained by the along-the-track scanning method is 336.8 mb whereas that obtained by the track counting method is 347.5 mb. (auth)

Strong (Meson-Induced)

29625 (INR-876/VI/PH) ANGULAR CORRELATIONS BETWEEN PIONS IN TEN-PRONG π^+ -P INTERACTIONS AT 8 GeV/c PRIMARY π^+-MOMENTUM. Eskreys, Andrzej; Wolek, Halina (Institute of Nuclear Research, Warsaw (Poland)). 1967. 10p. Dep.

The strong angular correlations between pions were found in 10-prong π^+ -p interactions at 8 GeV/c. The average opening angle of pion pair of like charges is smaller than that for pairs of unlike pions. This effect appears to be stronger in 10-prong interactions than in 8-prong interactions and much stronger than in 6-prong interactions at the same incoming momentum. (auth)

29626 (INR-P-882/VI/PH) ANGULAR CORRELATION BETWEEN π^0 MESONS PRODUCED IN π^- Xe INTERACTIONS AT 9 GeV/c π^- INCOMING MOMENTUM. Eskreys, Kinga (Institute of Nuclear Research, Warsaw (Poland)). 1968. 10p. Dep.

A strong angular correlation between neutral pions was found in the 9-GeV/c π^- Xe interactions observed in the xenon bubble chamber. The same kind of angular correlations were previously reported for charged pions produced in $\bar{p}$-p and $\pi^\pm$ -p interactions. (auth)

29627 (IS-T-225) A STUDY OF THE REACTIONS $K^-P \rightarrow K^-P\pi^+\pi^-\pi^0$ AND $K^-P \rightarrow K^-N\pi^+\pi^+\pi^-$ AT 4.6 AND 5.0 GeV/c. Juhala, Roland Edwin (Ames Lab., Iowa). Feb. 1968. Contract W-7405-eng-82. 145p. Dep. CFSTI.

Thesis.

The final states $K^-p\pi^+\pi^-\pi^0$ and $K^-N\pi^+\pi^+\pi^-$ were studied in K^-P interactions at 4.6 and 5.0 BeV/c. The data were prepared from 28000 pictures at each momentum taken in the 80" bubble chamber at Brookhaven National Laboratory. The cross sections for production of the final state $K^-p\pi^+\pi^-\pi^0$ are .76 ± .09 mb and .93 ± .12 mb, and for the final state $K^-N\pi^+\pi^+\pi^-$ .42 ± .06 mb and .39 ± .07 mb at 4.6 and 5.0 BeV/c, respectively. The effective mass distributions were studied by combining the data from both momenta. The effective cross sections for the combined data are .83 ± .12 mb for the $K^-P\pi^+\pi^+\pi^0$ final state and .41 ± .07 mb for the $K^-N\pi^+\pi^+\pi^-$ final state. The combined $K^-N\pi^+\pi^+\pi^-$ data consists of 701 events. The resonance production includes $\bar{K}^{*0}$ (890): 29 ± 4%, Δ^- (1236): 17 ± 3% and Δ^+ (1236): 7.0 ± 2.0%. There is, in addition, evidence for an enhancement at 960 MeV/c^2 in the $\pi^+\pi^+\pi^-$ mass spectrum of magnitude 6 ± 2%. A lower limit on double resonance production is estimated to be 5% with some evidence for $\Delta^-\bar{K}^{*0}\pi^+$: 3.7 ± 1.7%. No resonance observed in this final state could be understood exclusively on the basis of a single particle exchange process. The combined $K^-P\pi^+\pi^-\pi^0$ data consists of 1305 events. The resonance production includes $\bar{K}^{*0}$ (890): 19 ± 3%, K^{*-} (890): 7.2 ± 1.7%, Δ^{++} (1236): 15 ± 3%, Δ^+ (1236): 8 ± 3%, Δ^0 (1236): <2%, ω^0 (784): 14.5 ± 3%, η (548): 3.3 ± 1.3%, $A1^0$ (1080): 10.5 ± 3%, $A2^0$ (1300): 3 ± 1.5%, ρ^+ (760): 9 ± 2.5% and ρ^- (760): 5.5 ± 2%. A spin analysis of the $A1^0$ (1080) indicates an unnatural spin and parity assignment with 1^+ preferred. A lower limit on double resonance production is 6% with some evidence for $\Delta^+\bar{K}^{*0}\pi^-$: 4.0 ± 1.5% and $\Delta^{++}K^{*-}\pi^-$: 2.3 ± 1.0%. There is an indication for Δ^{++} (1236) production via a one-pion-exchange diagram. In general these two final states exhibit much larger four-momentum transfers to the baryon than the corresponding three-or four-body final states. Center of mass angular distributions for the baryon resonances were significantly backward peaked, while the K^* distributions were forward peaked, but no more so than for the background obtained by slicing above and below the resonance region. Quasi-two-body production due to small contributions from several channels, while marginal, could not be excluded. (auth)

29628 ANALYSIS OF 3π and 4π SYSTEMS WITH MASS AROUND 1.7 GeV/c^2 PRODUCED BY π^-p COLLISIONS AT 11 GeV/c. Caso, C. (Univ., Genoa. Instituto Nazionale di Fisica Nucleare, Genoa); Conte F.; Tomasini, G.; (and others). Nuovo Cim., 54A: 983-90(Apr. 21, 1968).

An analysis is made of the multipion mass spectra from 2795 events of the $\pi^-p \rightarrow \pi^-p\pi^+\pi^-$ reaction and 2658 events of the $\pi^-p \rightarrow \pi^-p\pi^+\pi^-\pi^0$ reactions, using combined data from exposures of the 2 m CERN-HBC and the 1.5 m BN-HBC to π^- beams at ~11 GeV/c.. The presence of at least a G = −1 and G = +1 enhancement in the region of 1.7 GeV/c^2 is detected. The results show that the 3π enhancement at 1.66 GeV/c^2 is predominantly a $f^0\pi$ system with I = 1. The 4π, I ≥ 1 enhancement near 1.7 GeV/c^2 was found to decay almost equally into $\rho\rho$ and $\rho\pi\pi$. (L.B.S.)

29629 DIPION SYSTEM IN π^+d INTERACTIONS AT 5.1 GeV/c: SEARCH FOR ϵ^0 AND g QUANTUM NUMBERS. Armenise, N.; (Univ., Bari, Italy. Istituto Nazionale di Fisica Nucleare, Bari, Italy); Ghidini, B.; Picciarelli, V.; (and others). Nuovo Cim., 54A: 999-1008(Apr. 21, 1968).

Experimental results are presented on the search for the ϵ^0 in connection with the ρ^0 asymmetry and on the $g \rightarrow \pi^+\pi^-$ quantum number investigation. 5802 events of the type $\pi^+ + d \rightarrow p_s\ p\pi^+\pi^-$ and 1570 $\pi^+ + d \rightarrow p_s\ p$ neutral events were analyzed from a bubble chamber exposure to a 5.1 GeV/c π^+ beam. No evidence for the ϵ^0 resonances ($I^GJ^P = O^+O^+$) was found. The experiment favored the $I^G = 1^+$ assignment for the $g \rightarrow \pi^+\pi^-$. (L.B.S.)

29630 K*(890) PRODUCTION IN 10 GeV/c K^-p INTERACTIONS AND COMPARISON WITH ABSORPTION AND REGGE POLE MODELS. Adorholz, M. (Technische Hochschule, Aachen); Gensch, U.; Bardadin-Otwinowska, M.; Dallman, D. P.; Frohlich, A.; (and others). Nucl. Phys., B5: 567-81(1968).

K* (890) and K* (1420) resonances are observed in 10 GeV/c K^-p interactions. Masses, widths and cross sections are determined. Decay angular distributions and differential cross sections of K* (890) production are compared with the absorption model and Regge pole model. While at lower energies the absorption model predictions are in reasonable agreement with experiment. Serious disagreement is observed at 10 GeV/c. Regge pole calculations including exchange of P, P', π, ρ, ω and A_2 trajectories can fit the data but do not explain why π exchange dominates K^{*0} (890) production while ω exchange dominates K^{*-} (890) production. (auth)

29631 MEASUREMENT OF PROTON POLARIZATION FROM π^{+-}p ELASTIC SCATTERING BETWEEN 550 and 1025 MeV. Bizard, G.; Bonthonneau, F.; Deregel, J.; (and others). (Univ., Caen, France). Nucl. Phys., B5: 515-22(1968). (In French).

The polarization parameter in πp elastic scattering was measured with π^- at 550 and 650 MeV and with π^+ at 765, 895, 955, and 1025 MeV, using a polarized proton target. (auth)

29632 N$\pi\pi$ ENHANCEMENTS OBSERVED IN THE REACTION $\pi^-n \rightarrow p\pi^-\pi^-\pi^0$ AT 5 GeV/c. Fleury, P. (Ecole Polytechnique, Paris); Huc, J.; Vanderhaghen, R.; Duboc, J.; George, R.; Goldberg, M.; Picciarelli, V.; Romano, A.; Quareni-Vignudelli, A. Phys. Lett., 26B: 686-8(Apr. 29, 1968).

In the search for nucleon resonance production in the reaction $\pi^-d \rightarrow (p_s)p\pi^-\pi^-\pi^0$ at 5 GeV/c, the $(p\pi^-\pi^0)$ and $(p\pi^-\pi^-)$ spectra are investigated. Signals are observed in the 1.7 GeV region; however their characteristics do not fully agree with what is known on nucleon resonance structures from phase shift analysis. While these discrepancies are not as significative as that reported in the preceding letter; they also point toward difficulties in correlating resonant structures in production reactions to those observed in formation processes. (auth)

29633 OBSERVATIONS OF NUCLEON ISOBARS IN THE REACTION $\pi^-n \rightarrow [p\pi^-]\ \pi^-\pi^0$ AT 5 GeV/c. Fleury, P. (Ecole Polytechnique, Paris); Vanderhaghen, R.; Goldberg, M.; Makowski, B.; Ghidini, B.; Romano, A.; Quareni-Vignudelli, A. Phys. Lett., 26B: 682-5(Apr. 29, 1968).

In the reaction $\pi^-d \rightarrow (p_s)p\pi^-\pi^-\pi^0$ at 5 GeV/c the $\{p\pi^-\}$ final state spectrum is investigated. A signal is seen at the position of the D_{13}-state central mass, namely 1518 MeV; its width is about three times narrower than the width of this D_{13}-state as firmly established by formation experiments. A qualitative explanation of this discrepancy is proposed. (auth)

29634 RESONANCES AND TOTAL REACTION CROSS SECTIONS. Giacomelli, Giorgio (Univ., Bologna). Rend. Semin. Mat. Fis. Milano, 37: 95-119(1967). (In Italian).

Results are presented of a series of total cross section measurements of $\pi^\pm$, $K^\pm$, $\bar{p}$ on hydrogen and deuterium for laboratory momenta between 1.0 and 3.3 GeV/c. Besides the well known resonances, 14 new structures are observed. A discussion of the consequences of the results follow. (auth)

29635 SEARCH FOR A NEGATIVELY CHARGED MESON NEAR 960 MeV. Barloutaud, R. (CEN, Saclay, France); Duong Nhu Hoa; Merrill, D.; (and others). Phys. Lett., 26B: 674-6 (Apr. 29, 1968).

Evidence is presented showing that the $\eta\pi\pi$ and $\rho\gamma$ enhancements near 960 MeV both have I = 0, thus supporting the current hypothesis that they are due to a single resonance η' and excluding their association with the I = 1 resonance δ(963). (auth)

29636 A MEASUREMENT OF THE DIFFERENTIAL CROSS SECTIONS FOR CHARGE EXCHANGE AND RADIATIVE CAPTURE OF NEGATIVE PIONS IN HYDROGEN AT 50 MeV LABORATORY ENERGY. Carroll, Jim Byars. Berkeley, Calif., Univ. of California, 1967. 62p.

Thesis.

The differential cross sections of $\pi^- + p \rightarrow \gamma + n$ and $\pi^- + p \rightarrow \pi^0 + n(\rightarrow \gamma + \gamma + n)$ were measured at an incident pion laboratory-system kinetic energy of 54 MeV. The reactions were identified by detecting and measuring the energy of a final-state photon with a large total absorption counter placed at a laboratory-system angle of 84°. Analysis of the photon energy spectrum yields the cms differential cross section for the first reaction, $d\sigma_1/d\Omega^* (\theta^* = 90°) = 51.5 \pm 10.7$ μb/sr, and the coefficients of the Legendre expansion of the cms system differential cross section for the second reaction, $d\sigma_2(\theta^*)/d\Omega^* = \sum_{l=0}^{2} A_l P_l (\cos\theta)$, where $A_0 = 0.68 \pm 0.04$ mb/sr, $A_2 = 0.53 \pm 0.09$ mb/sr, and A_1 is not determined. Using the principle of detailed balance, and the measurement of the cross section for the first reaction, the isotropic term in the cross section for the reaction $\gamma + n \rightarrow \pi^- + p$ was calculated and $a_0^- = 15.4 \pm 3.2$ μb/sr at $p_\gamma^* = 170$ MeV/c was obtained. This value is in reasonable agreement with other data obtained from photoproduction in deuterium. (Disser. Abstr.)

29637 $\bar{K}\pi\pi$ SYSTEM IN THE REACTION $K^-p \rightarrow K^-\pi^+\pi^-p$ AT 5.5 BeV/c. Park, Joseph Chul-hui. Urbana, Ill., Univ. of Illinois, 1967. 263p.

Thesis.

An experiment was performed in which 436,000 exposures were taken using the separated K^- beam at the 30 in. hydrogen bubble chamber. As a part of this experiment a study of the $\bar{K}\pi\pi$ system in the reaction $K^-p \rightarrow K^-\pi^+\pi^-p$ at 5.5 BeV/c was carried out. The following results are obtained in this study; evidence that the Deck mechanism plays a dominant role in $K^{*0}(890)$ production leading to a broad enhancement in the $\bar{K}\pi\pi$ system at low mass, no definite evidence for $\bar{K}^{**}(1320)$ production, evidence for $\bar{K}^{**}(1430)$ production with subsequent decay into $\bar{K}^*(890)$ and π, supporting evidence for the recently discovered L(1789) meson, and finally, indications for a new resonance in the $\bar{K}\pi\pi$ system at 2.02 BeV. (Diss. Abstr.)

29638 NEGATIVE PION–PROTON INTERACTIONS AT 4.65 GeV/c. Elattar, Ahmed Lotfy. Athens, Ohio, Ohio Univ., 1967. 106p.

Thesis.

No basic theory has yet been formulated to explain the mystery of nuclear forces. The present investigation is a part of a large scale effort to collect experimental data which might contribute toward elucidating that mystery. Negative pion-proton interactions at 4.65 GeV/c resulting in two charged secondaries are studied for elastic scattering and single pion production. The dynamics of these interactions are studied to check the validity of existing theoretical models. Interactions of negative pions at 4.65 GeV/c from the alternating gradient synchrotron with protons in the bubble chamber were photographed. The film was scanned and measured using conventional digitizers. 3500 two-prong events were analyzed using geometrical reconstruction program TRED and kinematical fitting program GUTS. The events were classified into elastic collisions, single pion production or multi-pion production according to the visual identification of the outgoing positive tracks. The genuinity of this classification was tested by the X^2 and by the missing mass distributions. Elastic scattering results were compared with optical model and Regge pole theorem predictions. Single pion production events were investigated for mesonic and baryonic resonances using both energy plot and four momentum transfer techniques. The overall cm distributions were also plotted. Interaction mechanisms were studied in the light of the one pion exchange (OPE) and the absorptive OPE models. The total cross section for these interactions is estimated at 19.40 ± 0.28 mb without correcting for scanning losses. There are 1044 events classified as elastic collisions, 383 events as $\pi^0 p$ and 568 events as $\pi^+ n$ production. The rest of the 3500 events are multipion production. The cm angular distribution for elastic collisions shows a diffraction peak which contains almost all of the total elastic cross section (97% of the total elastic collisions occur below 32°). This peak is fitted by a simple optical model considering the proton an opaque disc with radius 0.815 f. The four momentum transfer to the protons (t) is fitted by an exponential function of the second power in t. Elastic events show no evidence for backward scattering. Dalitz plots and invariant mass plots for one pion production confirmed the presence of the resonances, ρ^-(775 MeV), ρ^0(750 MeV), f^0(1225 MeV) and N^{*++}(1400 MeV) observed in similar experiments. A dipion resonance G-meson (1675 MeV) is observed in the $\pi^0\pi^-$ but not in the $\pi^+\pi^-$ state. This is in consistence with an iso-spin assignment of T = 2 for the G-meson. A baryonic resonance is suspected around 2600 MeV in the $p\pi^-$ and $n\pi^-$ states. The overall cm momentum distributions imply the two-body nature of the interactions. On the other hand, the cm angular distributions show that the dipion resonances dominate these interactions. The four momentum transfer to the resonances show that ρ^- and ρ^0 are more peripheral than f^0 and the latter in turn is more peripherally produced than G^-. G^- disappeared from mass plots for events with momentum transfer below 0.2 GeV² while f^0 disappeared below t = 0.1 GeV². The angular distributions in the resonance center of mass system peak in the forward and in the backward directions more than the $(A + B\cos^2\theta)$ formula of the absorptive model predicts. The absorptive model predictions for the matrix elements are in fair agreement with the experimentally determined ones. For the ρ^- resonance $\rho_{00} = 0.677 \pm 0.007$ compared to 0.644 predicted by the model and $\rho_{1-1} = 0.307 \pm 0.003$ compared to 0.167 by the model. For the ρ^0 resonance the values are 0.833 ± 0.032 and 0.294 ± 0.001 subsequently with no predictions available. The four momentum transfer to the resonances, however, is in good agreement with the absorptive model. (Disser. Abstr.)

29639 STRANGE PARTICLE PRODUCTION IN π^-p AND π^+n INTERACTIONS AT 2.5 GeV/c. Hanft, Raymond William. Urbana, Ill., Univ. of Illinois, 1967. 201p.

Thesis.

A bubble chamber experiment based upon 2.71×10^5 m π^- track length in hydrogen and 6.88×10^5 m π^+ track length in deuterium was performed to study strange particle production. Cross sections for the π^-p reactions exhibit no marked departure from trends established by other experiments at nearby energies. In extracting information about π^+n interactions from the π^+D exposure it was found that 15 to 30% of events, depending on the final state particles, had protons with momentum greater than 250 MeV/c. These protons were not isotropic in the laboratory and therefore not spectators in the sense of the impulse approximation. Protons whose momentum lay in the interval 0 to 250 MeV/c were generally isotropic, and their momentum distribution agreed moderately well with a Hulthen distribution normalized over this interval. With the inclusion of the high proton momentum events the cross sections for processes apparently arising from π^+n interactions were found to be in satisfactory agreement with cross sections for the charge symmetric π^-p reactions. In the reaction $\pi^+n \rightarrow K_1^0(K^0)p$ evidence for weak φ production corresponding to about 10 μb cross section was obtained. No other enhancements in the $K\bar{K}$ or $K\bar{K}\pi$ systems were seen. $Y K\pi$ and $Y K\pi\pi$ states were found to be dominated by resonance production. However in $\Lambda K\pi$ states the $Y_1^*(1385)$, prominent at lower energies, was quite weak, thereby permitting measurement of the spin density matrix elements for $K^*(892)$ production in the ΛK^* state. The obtained value of $\rho_{00} = .45 \pm .08$ can be interpreted on the basis of the single particle exchange model as indicating that vector (K^*) exchange is somewhat more important than scalar (K) exchange. Similar results were obtained for the $\Sigma^* K^*$ state. Although it was not clearly observed in $\pi^-p \rightarrow K^*(\Sigma\pi)^0$, a $Y^*(1660)$ was observed in $\pi^+n \rightarrow K^+(\Sigma\pi)^0$. The appearance of this Y^* in these data and its absence in data at higher energies indicates the excitation function for $\pi N \rightarrow KY^*(1660)$ is appreciable only in a small energy interval above threshold. (Diss. Abstr.)

29640 STUDY OF TWO-BODY FINAL STATES IN K^-N INTERACTIONS FROM 1600 TO 1720 MeV/c. O'Neall, John S. Tallahassee, Fla., Florida State Univ., 1967. 215p.

Thesis.

In order to study the formation of resonances with energies in the neighborhood of 1660 MeV, K^-d interactions for incident K^- momenta of 670, 720, 770, 850, and 910 Mev/c were studied. The impulse model was used to examine two-body final states resulting from K^--nucleon interactions. Evidence was seen for the formation of Σ(1660) in the reaction $K^-n \rightarrow \Lambda\pi^-$, although the data were insufficient to rule out the possibility that the observed structure is due to statistical fluctuations. It was observed, however, that previous experiments would have failed to see this structure because of the narrow width of the energy interval necessary for this purpose. Data from this experiment for the reaction $K^-n \rightarrow \Sigma^0\pi^-$ were used in conjunction with data from other experiments for the reactions $K^-p \rightarrow \Sigma^0\pi^0$, $K^-p \rightarrow \Sigma^+\pi^-$, and $K^-p \rightarrow \Sigma^-\pi^+$. The multichannel analysis used, based on the conservation of I-spin, indicated the presence of two resonances, Λ(1680) and Σ(1660), in the $\Sigma\pi$ channel. No unambiguous evidence of the reaction $K^-d \rightarrow \Sigma\Delta$ could be found, and an average value of (0.06 ± 0.02) mb was obtained for the cross section for the reaction $K^-d \rightarrow \Sigma^-p$ over the energy range, 2610–2750 MeV. These findings, coupled with the success of the Hulthen model in the prediction of momentum spectra for the spectator nucleons in the reactions studied, indicate the applicability of the impulse model and the rarity of occurrence of interactions between the K^- and the deuteron as a whole. The data for the angular distributions of the reaction

products were insufficient to make possible a determination of the spin and parity of the Λ(1680) or the Σ(1660). (Diss. Abstr.)

29641 A STUDY OF ($\Sigma^{\pm}\pi^{\mp}$) PAIR EMISSION FROM K^- MESON ABSORPTIONS AT REST BY EMULSION NUCLEI. Lovell, S. P. (University Coll., London); Schorochoff, G. Nucl. Phys., B5: 381-91(1968).

The energy and momentum distributions of 1454 ($\Sigma\pi$) pairs, separated between those produced by K^- meson interactions occurring on the light (carbon, nitrogen and oxygen) and on the heavy (silver and bromine) emulsion nuclei, have been studied. The Auger electron yield in heavy nuclei for events of this type has been measured. (auth)

Particle Interactions and Properties (Theoretical)

General

29642 (ITF-67-21) ON A GENERALIZATION OF LIE ALGEBRAS. Stawraki, G. L. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1967. 15p. Dep.

Considerations favoring some quasi-simultaneous commutation relations for a set of interacting fermion and boson fields are more general than those for free fields. In these relations commutators and anticommutators of the field operator components are no longer c-numbers but linear functions of the operator components of the same set of fields. The set of such commutation relations constitutes a sort of unassociative algebra more general than Lie algebra. Such algebras are called K-algebras. The mathematical description of these K-algebras and some general properties without any application to physics are given. (J.F.P.)

29643 (ITF-67-46) ZADACHA MNOGIKH TEL S GAUSSOVSKIM POTENTSIALOM. (Many-Body Problem with Gaussian Potential). Filippov, G. F. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1967. 18p. (In Russian). Dep.

A method developed earlier is applied to calculate the binding energy of Bose and Fermi systems with a Gaussian two-particle potential. The result is presented as a series in the decreasing powers of N. (auth)

29644 (NP-17452) ABOUT O'RAIFEARTAIGH'S THEOREM. Fuchs, Gerard (Ecole Polytechnique, Paris (France). Centre de Physique Theorique). Mar. 1968. 13p. Dep.

A study of the previously made conjecture that any semi-simple Lie algebra G having Poincare as a subalgebra also contains a dilatation (i.e., an element commuting with the Lorentz generators and having translation generators for eigenvectors) is presented. It is shown that the conjecture which would have given a result somewhat more precise than O'Raifeartaigh's theorem and of purely algebraic nature is not true. A rule is given to construct counter examples of arbitrarily high dimension for any type of algebra. (J.F.P.)

29645 BRA-KET FORMALISM FOR FREE RELATIVISTIC PARTICLES. Fong, R.; Rowe, E. G. P. (Univ. of Durham, Eng.). Ann. Phys.(N. Y.), 46: 559-76(1968).

Relativistic single particle theories are presented from the point of view of the bra-ket formalism of Dirac. Not only does this give a coherent and unified formulation of the theory but also clarifies the relationship between and meaning of the different forms of amplitudes and of the position operator that exist in the literature. (auth)

29646 DEVELOPMENT OF A NEW DIRECTION IN THE THEORY OF ELEMENTARY PARTICLES. Akulov, N. S. (Belorussian Academy of Sciences, Minsk). Dokl. Akad. Nauk BSSR, 11: 777-81(Sept. 1967). (In Russian).

It is postulated that the formula for calculating the kinetic masses of reons, that is, of the decay products ν_e, ν_μ and $e^\pm$ of the elementary particles $\mu^\pm$, π^0 and $\pi^\pm$ does not contain any arbitrary empirical constants, and its use leads to excellent agreement with experiment for the mass of a series of elementary particles, in particular, of kaons. In place of decay schemes composition schemes are considered. Thus it becomes possible to uncover the structure of elementary particles and to determine their masses. By using the method of particle composition a value of 105.8 MeV/c^2 is obtained for the $\mu^\pm$ mass, which is in good agreement with an experimental value of 105.7 MeV/c^2. Similarly a value of 134.94 MeV/c^2 is found for the π^0 mass, which is in excellent agreement with an experimental value of 134.97 MeV/c^2. For the π^+ mass the calculated value is 139.54 MeV/c^2 compared to an experimental value of 139.58 MeV/c^2. (TTT)

29647 LOCAL FORMS OF SECOND AND HIGHER ORDERS IN THE THREE-DIMENSIONAL RIEMANN SPACE OF POSITIVELY DEFINED METRIC AND ELEMENTARY PARTICLES. Boerner, Manfred. Z. Naturforsch., 22A: 1835-41(Dec. 1967). (In German).

In the continuation of an earlier study (Z. Naturforsch., 22A: 1825 (1967)) the simplest structure of this space was investigated. Only those space structures which arise in the orthogonal transformation in the local system of normal coordinates are regarded as identical. Then a representation of the metric field can be given in which six independent components of pseudotensors of each differential stage p determine the structure. The theory of orthogonal invarients $I_s^{(p)}$(s = 1, 2, 3) of these pseudotensors make possible a classification. The invarient system of the lowest order I_s leads therefore to a physical structure immediately detectable as such when $I_1 = 0$, $I_2 \neq 0$, and $I_3 = 0$. The field ℭ and ℌ were recognized as constituents of the curvature tensor which in three dimensions can be represented as a curvature tensor of the second stage. The usual reversible time parameter t was introduced in a limiting process. The significance of the invarients for procuring additional elementary physical structures and their interactions was discussed. (tr-auth)

29648 n-PARTICLE KINEMATICS. Roffman, Eric H. (Courant Inst. of Mathematical Sciences, New York. Inst. for Advanced Study, Princeton, N. J.). J. Math. Phys. (N. Y.), 9: 62-5(Jan. 1968).

A very simple method is suggested for handling relativistic n-body kinematics. In fact the method works well for studying the n-fold Kronecker products of the representations of many groups, including all compact Lie groups as a simple case. The method is explicitly covariant, and treats all particles symmetrically. (auth)

29649 THE FRENKEL-KRAMERS MODEL AND THE ZITTERBEWEGUNG IN THE EXTENDED HEISENBERG PICTURE OF THE DIRAC ELECTRON. Yamasaki, Hisaiti (Kyusyu Dental Coll., Japan). Progr. Theor. Phys. (Kyoto), 39: 372-93(Feb. 1968).

With respect to the principal operators including the sixteen 4-4 matrices of the Dirac electron, two covariant forms of the extended Heisenberg picture can be presented with the "two covariant Hamiltonians H_I and H_{II}" of the first and second order, respectively. One form with H_{II} involving the proper electromagnetic moment corresponds perfectly to the Frenkel-Kramers model which was recently treated by the author; the other form with H_I containing the Zitterbewegung corresponds partly to the so-called Weyssenhoff-like model. That an amalgamation of the former form and the Zitterbewegung brings immediately the latter is explicitly shown by virtue of a decomposition of the operator of the Dirac electron into two corresponding parts. This decomposition is derived from the extension of the Feynman-Bunge-Corben formula for the position operator of the electron and, in case without external fields, it corresponds to the covariant form of the so-called "gerade-ungerade" decomposition. In the case of the free state mixed with positive and negative energy, the Zitterbewegung of operators derived from H_I can properly be realized by the expectation values of the operators. In this process, the complex hyperbolic metric of velocity which represents a new negative energy state plays an essential role. These results give an important clue to solve the puzzling problem of the construction of a consistent classical model for the Dirac electron, and also may be useful for investigation of "internal structure" of elementary particles as well as their spin. (auth)

29650 QUANTIZATION OF RELATIVISTIC ACTION-AT-A-DISTANCE THEORIES. Cooke, James Horton. Chapel Hill, N. C., Univ. of North Carolina, 1967. 67p.

Thesis.

Relativistic action-at-a-distance mechanics constitutes a definite alternative to classical field theory. It has a simple formulation, and is free of the self-energy divergence. The quantization of action-at-a-distance theories presents special problems, since no simple Hamiltonian form is available. Feynman's path integral technique can furnish a definition for the S-matrix, but there is no proof for its unitarity. On the other hand, conventional quantum electrodynamics can be put into a path integral form for comparison with the proposed S-matrix theory. This procedure requires a wave-function representation $\psi(A_\mu)$ for the electromagnetic field which conforms to the requirements of Lorentz and gauge invariance. There is a way to represent the methods of Gupta and Bleuler, even though the wavefunctions are not in the usual L^2 Hilbert space. The unitarity of the proposed theory is not proven but there is no difficulty in defining a conserved electrical current. Also, the theory describes, in a natural way, the creation and interaction of particles of differing masses. (Diss. Abstr.)

29651 BEHAVIOUR OF FREE ELECTRONS AND POSITRONS WITHIN A CLOSED METALLIC CONTAINER. Held, A. (Queen Elizabeth Coll., London). Nuovo Cim., 54A: 976-8(Apr. 21, 1968).

The problem of a free-falling positron or electron within a closed metallic container is studied using an entirely classical description. (L.B.S.)

Electromagnetic

Refer also to abstracts 29668 and 29705.

29652 (DESY-68/6) VECTOR MESON DOMINANCE ANALYSIS OF DATA ON THE REACTION $\pi^- + p \rightarrow \rho^0 + n$. Krammer, Margarete (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Feb. 1968. 7p. Dep.

The data on the reactions $\gamma p \rightarrow \pi^+ n$ and $\pi^- p \rightarrow \rho^0 n$ are compared. The V.D.M. relation is found to be satisfied at small momentum transfers. There are discrepancies for higher $|t|$ and at the maximum energy investigated. (auth)

29653 (DESY-68/15) NON-FORWARD PHOTOPRODUCTION OF ρ^0 MESONS FROM COMPLEX NUCLEI. Fleischer, J. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Mar. 1968. 11p. Dep.

The nonforward coherent photoproduction of ρ^0 mesons was calculated following closely the model of Drell and Trefil, and Ross and Stodolsky. Inside the nucleus the ρ^0 wave functions shall satisfy the Klein–Gordon equation with a purely imaginary potential. From the wave function at the nuclear surface the production amplitude is constructed by the Kirchhoff method known from classical optics. In a recent experiment indications of diffraction minima and maxima were observed, the general features of which seem to be well reproduced by this calculation. (auth)

29654 (DESY-68/16) SEPARATION OF INFRARED CONTRIBUTIONS TO RADIATIVE CORRECTIONS IN TERMS OF AN EXPONENTIAL FACTOR UNDER GENERAL EXPERIMENTAL CONDITIONS. Kohaupt, R. D. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Mar. 1968. 20p. Dep.

It is shown that the usual splitting of infrared contributions to radiative corrections in terms of an exponential factor cannot be valid under general kinematical conditions. A modified formula is derived which avoids the shortcomings of the original formulation. The approximations made in this context are discussed in detail. (auth)

29655 CYCLOTRON WAVES IN A DEGENERATE ELECTON FLUID. Silin, V. P. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz., 54: 1016-22(Mar. 1968). (In Russian).

The spectra of some electromagnetic waves which may be propagated in a degenerate electron Fermi liquid in a magnetic field are considered in detail. Dispersion equations are obtained for the ordinary, nonordinary and plasma waves propagated across the magnetic field. It is shown that a strong interaction of oscillations with frequencies close to the limiting frequencies of excitation of a homogeneous field in an electron fluid is possible even for long waves. Some possibilities are discussed for determining experimentally the quantities characterizing the correlation of electrons and responsible for the difference of an electron fluid from gas. (auth)

29656 DYNAMICAL APPROACH TO THE HADRON MASS SPLITTINGS. Flamm, D.; Majerotto, W. (Institut fuer Hochenergiephysik, Vienna). Nuovo Cim., 54A: 1016-19(Apr. 21, 1968).

The ω-φ mixing model is applied to the calculation of the quark electromagnetic mass splitting. (L.B.S.)

29657 ELECTRIC FORM FACTOR OF THE NUCLEON. Cheng, Hsi-t'e; Wong, K'o-lin; Wang, Min-chung. Chin. J. Phys. (Peking) (Engl. Transl.), 21: 1849-55(May-July 1965).

Translated from Wu Li Hsueh Pao, 21: 1464-8(July 1965).

The structure of the nucleon is investigated under the assumption that the distribution of the nucleon core is spherically symmetric. Computational results for the proton mean square radius and the proton electric form factor are found to be in good agreement with the empirical results. (L.B.S.)

29658 ELECTROMAGNETIC MASS SHIFTS, COMMUTATOR AMBIGUITIES, AND EXPONENTIALLY FALLING FORM FACTORS. Brandt, Richard; Sucher, Joseph (Univ. of Maryland, College Park). Phys. Rev. Lett., 20: 1131-4(May 13, 1968).

A connection is suggested between the ambiguities in the definition of the equal-time commutator $[j_\mu^{em}(0,\vec{x}), J_\nu^{em}(0)]$ and the experimental indications of an exponentially falling electromagnetic form factor for the nucleon. On this basis, a resolution is proposed of the difficulty of current-algebra models which appear to give divergent expressions for the electromagnetic mass shifts of hadrons. (auth)

29659 RADIATION EFFECTS IN EXPERIMENTS WITH COLLIDING ELECTRON–POSITRON BEAMS. Sukhanov, S. M.; Fadin, V. S.; Khoze, V. A. (Novosibirsk State Univ., USSR). Dokl. Akad. Nauk SSSR, 178: 822-4(Feb. 1968). (In Russian).

Expressions are found for the cross section of electron–positron scattering with emission of a photon of arbitrary energy over a narrow cone along the direction of particle motion. The cross section for emission of soft quanta is obtained for arbitrary scattering angles of the electron. Expressions are obtained for radiation corrections to the electron–positron scattering cross section with the retention of log terms in the calculation. These formulas will be useful in estimating the emission of photons during electron–positron collisions in interacting beams. (TTT)

29660 HADRONIC CONTRIBUTIONS TO THE MUON MAGNETIC MOMENT. Bowcock, J. E. (Univ., Tuebingen, Ger.). Z. Phys., 211: 400-3(1968).

Using the recent experimental data on the pion form factor in the time-like region limits are placed on the 2π contribution to the muon magnetic moment and the ω and ϕ contributions estimated. (auth)

29661 HARD VAVILOV–CHERENKOV RADIATION AT MODERATE ENERGIES. Batygin, V. V. (Leningrad Polytechnic Inst.). Zh. Eksp. Teor. Fiz., 54: 1132-6(Apr. 1968). (In Russian).

The kinematics is considered and the probability for hard Vavilov–Cherenkov radiation in the nonrelativistic and moderately relativistic energy region of radiating particles is determined (previously such a treatment was presented for ultrarelativistic particles). The conditions under which hard Vavilov–Cherenkov radiation can be observed and distinguished from bremsstrahlung radiation are considered. These conditions can apparently be attained experimentally at the present time. (auth)

29662 MULTIPOLE-ANALYSIS IN π^0-PHOTOPRODUCTION ON PROTONS BELOW E = 234 MeV. Muellensieffen, A. (Univ., Karlsruhe, Ger.). Z. Phys., 211: 360-72(1968).

Taking ReM_{1-} as a parameter ReE_{0+}, ReE_{1+} and ReM_{1+} are determined by a phenomenological analysis using the measurements of Hitzeroth and Govorkov et al. Taking for ReM_{1-} the present theoretical values ReE_{1+} turns out to be negative. $|ReE_{0+}|$ is smaller than former theoretical calculations suggest. The influence of the imaginary parts and of the higher multipoles is discussed. (auth)

29663 NUCLEON ELECTROMAGNETIC FORM FACTORS AND VECTOR-BOSON RESONANCES. Wataghin, V. (Univ., Turin. Istituto Nazionale di Fisica Nucleare, Turin). Nuovo Cim., 54A: 840-8(Apr. 21, 1968).

A three-pole expression for the electric proton form factor as a function of the ρ_0, ω, ϕ vector boson resonances is compared to experiment in the spacelike region $-10\ (GeV)^2 < t < 0$. The three unknown parameters which enter the expression are determined by a least-squares method. An analytical continuation is made into the timelike region $t > 0$. Crossing symmetry and microscopic causality are shown to hold. The connection between a well-known empirical formula for the form factor and the proposed expression is established. (auth)

29664 STOCHASTIC AUTO RESONANT ACCELERATION OF CHARGED PARTICLES. Davydovskii, V. Ya. (Inst. of Nuclear Physics, Alma-Ata, USSR). Zh. Eksp. Teor. Fiz., 54: 1264-9 (Apr. 1968). (In Russian).

A study is made of the acceleration of charged particles of a randomly polarized plane transverse electromagnetic wave propagated along a constant homogeneous magnetic field. It is shown that in the resonance case when the characteristic field frequency equals the gyrofrequency of particles, the average kinetic energy of the latter may increase considerably. It is supposed that the effect may take place in cosmic conditions. (auth)

29665 THRESHOLD BEHAVIOR ON THE COMPTON SCATTERING AND ELECTRON–NEUTRINO PHOTOPRODUCTION AMPLITUDES. De Baenst, P.; Pestieau, J. (Univ., Louvain, Belgium). Ann. Soc. Sci. Brux. Ser. I, 82: 79-90(1968).

The scattering of "isovector photons" by pions in the neighborhood of the threshold is investigated. Using divergence conditions, one obtains the low-energy part of the amplitude. Assuming then unsubstracted dispersion relations, the sum rules of Cabibbo-Radicati and Harari-Pagels are derived. Finally the threshold vector dominance hypothesis proposed by Sakurai is extended to the case of Compton scattering of "isovector photons" by pions, and it is shown that it implies the ρ-dominance model for the pion form factor. (auth)

29666 DOUBLE PION PHOTOPRODUCTION AND RADIATIVE PION NUCLEON SCATTERING. Huang, Huey Wen. Ithaca, N. Y., Cornell Univ., 1967. 82p.

Thesis.

The low-energy total amplitude for double pion photoproduction is expressed in several parts by using the equal time current commutation relations and the hypothesis of the partial conservation of the axial vector current. The final state interaction theory is then applied to calculate the cross sections. In comparison with the static theory, there are additional terms in the method which play an important role in the angular distributions but not in the total cross sections. The results are in fair agreement with the experiments on the total cross sections as well as the angular distributions. The dynamical and kinematical approximations involved are discussed in detail. An explicit amplitude for the low energy radiative pion nucleon scattering is derived in an isobar model resembling that of Olsson and Yodh. Crossing relations and the time reversal invariance make it possible to exploit some results of the double pion photoproduction. The final results involve three not-yet-measured electric and magnetic moments of $\Delta(1236)$ but no arbitrary parameters in contrast to the Olsson-Yodh model. (Diss. Abstr.)

29667 CALCULATION OF $e^-e^+ \rightarrow N^*\bar{N}^*$ PROCESSES. Benayoun, Maurice; Kessler, Paul. Cah. Phys., No. 205, 357-70(Sept. 1967). (In French).

In view of future electron-positron colliding beam experiments, the differential cross section was calculated for the reaction $e^+e^- \rightarrow N^*\bar{N}^* \rightarrow N\pi\bar{N}\pi$. Using a simplified technique of Feynman diagram calculation by vertex factorization, the result was obtained as a sum of 14 terms, which are bilinear combinations between the five independent helicity amplitudes existing for the vertex γN^*N^*. Those helicity amplitudes appear themselves as linear combinations of five form factors. Numerical predictions were obtained from a simplified model based upon presumed similarity between electromagnetic form factors of the N^* and the nucleon. (auth)

Weak

29668 (NP-17451) THE DECAY SPECTRUM OF POLARIZED MUONS IN THE GENERAL FERMI INTERACTION. Florescu, Viorica; Kamei, Osamu (Ecole Polytechnique, Paris (France). Centre de Physique Theorique). Feb. 1968. 19p. Dep.

A general expression for the decay spectrum of the polarized muon is obtained assuming the general Fermi interaction with radiative corrections. This permits discussion of the decay spectrum within 1% accuracy. New parameters φ and $\varkappa$ are introduced to display the deviation from the V,A interaction. The measurement of these parameters is not much more difficult than that of the usual low-energy parameter η, but is cutoff dependent. (auth)

29669 INTERMEDIATE VECTOR BOSON EFFECTS IN HIGH-ENERGY νN "ELASTIC" REACTIONS. Chu, Hsee-wen; He, Hsiang-sheng; Tseng, Shee-chih. Chin. J. Phys. (Peking) (Engl. Transl.), 22: 695-700(Feb. 1967).

Translated from Wu Li Hsueh Pao, 22: 945-51(Aug. 1966).

Using the intermediate vector boson (IVB) theory and Cabibbo's SU_3 model for the weak interaction, the analytical expressions and numerical results for the differential cross sections and the longitudinal polarizations of the final state particles of several νN "elastic" reactions were obtained. The results show that, for the given set of form factors usually assumed, the IVB effects on the longitudinal polarizations of the leptons and the hyperons are substantial near certain outgoing angles when the neutrino energy is high enough. The results also show that some information about the form factors and the mass of the IVB can be obtained from the experimental results of the differential cross section and the longitudinal polarization taken together if they are accurate enough. The nuclear effects and the effect of the neutrino beam energy spectrum on the longitudinal polarization of the muon were estimated for the process $\nu_\mu + [Z, A] \rightarrow \mu^- + [Z + 1, A]$. (auth)

29670 NEW SOLUTION TO THE COSMOLOGICAL EQUATIONS FOR A NEUTRINO-FILLED UNIVERSE. Wataghin, A. (Univ., Genova, Italy). Nuovo Cim., B, 55: 258-62(May 11, 1968).

In this paper we wish to analyse the consequences which may happen if the neutrino fluid is effectively dominant. (auth)

29671 NON-EXPONENTIAL LAW OF DECAY AND INTERFERENCE EXPERIMENTS. Khalfin, L. A. (Leningrad Division of the Mathematical Inst.). Dokl. Akad. Nauk SSSR, 172: 1059-62(Feb. 11, 1967). (In Russian).

The decay probability L(t) is determined as $L(t) = |p(t)|^2 = M^2(t)$, where $p(t) = \int_{E_{min}}^{\infty} \exp(-iEt/\hbar)\omega(E)\,dE = M(t)\exp[iN(t)]$. Here $\omega(E)$ is the energy (mass) distribution of the decaying state, and E_{min} is the boundary below the energy distribution, which is determined by the rest masses of the decay products. It is shown that L(t) cannot decrease exponentially as $t \rightarrow \infty$. Derivations from the exponential decay law are generally determined by the fine details of the behavior of $\omega(E)$. Conditions are defined where the contribution of the nonexponential term to the decay probability L(t) is large in comparison with the contribution from the main exponential term. It is not possible to determine directly the nonexponential term due to slight statistical accuracy. It is pointed out that interference experiments which depend not only on the modulus M(t) but also on the phase (of the argument) N(t) of the function p(t) will give the value of the nonexponential term, since its contribution will be large compared to the contributions from the exponential terms. (TTT).

29672 NONLEPTONIC DECAY PROCESS. Hayashi, Takemi; Ogawa, Shuzo; Okonogi, Hisaichiro; Yonezawa, Minoru (Hiroshima Univ.). Progr. Theor. Phys. (Kyoto), 39: 411-19(Feb. 1968).

A reasoning for the pole approximation of the nonleptonic decay is given on the basis of the viewpoint of the one-hadron-exchange model, and revised numerical results are also given. A discussion of the $\Delta I = \frac{1}{2}$ rule is made. (auth)

29673 RADIATIVE CORRECTIONS TO $\Lambda^0 \rightarrow N\pi$ AND $K_s \rightarrow 2\pi$ DECAYS. Belavin, A. A.; Narodetsky, I. M. (Inst. for Theoretical and Experimental Physics, Moscow). Phys. Lett., 26B: 668-9(Apr. 29, 1968).

The radiative corrections to $\Lambda^0 \rightarrow N\pi$ and $K_s \rightarrow 2\pi$ are calculated under assumptions of the $\Delta T = \frac{1}{2}$ rule and T-invariance. The essential contribution is due to the "Coulomb" term $\pi\alpha/v$. (auth)

29674 SYMMETRY OF RELATIVISTIC PROBLEMS. Malkin, I. A.; Man'ko, V. I. (Lebedev Inst. of Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.), 7: 79-81(Feb. 1968).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 7: 105-7(Feb. 5, 1968).

It is shown that in the model of the unified electromagnetically weak interaction the assumption that the (V + A)-form strangeness-changing hadron currents in the nonleptonic current-current, $|\Delta S| = 1$, CP-odd weak interaction makes it possible to determine the unitary structure of the latter, which is in satisfactory quantitative agreement with the experimental data on $K \rightarrow 2\pi$ decays and in general qualitative correspondence with the nonleptonic rule $|\Delta T| = \frac{1}{2}$ for all nonleptonic processes. (J.F.P.)

29675 TEST OF THE NATURE OF NONLEPTONIC WEAK INTERACTIONS IN HIGH-ENERGY NEUTRINO COLLISIONS. Abarbanel, Henry D. I. (Princeton Univ., N. J.). Ann. Phys. (N. Y.), 46: 335-46(Feb. 1968).

Through the use of the Gell-Mann algebra of currents and the current-current form for the nonleptonic weak Lagrangian, certain combinations of s-wave hyperon decay amplitudes are expressed in terms of integrals over the absorptive parts of the forward "scattering amplitude" of a weak current on baryons. Employing the technique of Cottingham it is shown that by a rotation of the contour of integration these absorptive parts are related to functions directly measurable in high-energy neutrino reactions. The assumed correctness of certain unsubtracted dispersion relations then allows an experimental test of the current-current nature of the nonleptonic weak interactions. (auth)

29676 TRIANGULAR DIAGRAM IN THE DECAY $Y_0(1520) \rightarrow \Lambda\pi\pi$ AND THE DETERMINATION OF THE PION SCATTERING LENGTH. Anisovich, V. V.; Levin, E. M.; Likhoded, A. K. (Ioffe Inst. of Physics and Tech., Leningrad). JETP Lett. (USSR) (Engl. Transl.), 7: 74-6(1968).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 7: 99-101(Feb. 5, 1968).

Since the decay $\Lambda(1520) \rightarrow \Sigma(1385) + \pi \rightarrow \pi + \pi + \Lambda$ proceeds in two stages, the contribution of the triangular diagram to it should be appreciable if the value of a_0 is not small. The logarithmic singularity of this diagram leads to a characteristic variation of the spectrum of the two pions in the $\Lambda(1520) \rightarrow \Lambda + \pi + \pi$ decay. The $\pi\pi$ spectra in the $\Lambda(1520) \rightarrow \Lambda + \pi + \pi$ decay at different values of the total system energy within the limits of the $\Lambda(1520)$ resonance width are shown. Attention is called to the rather single-valued character of the decay. This is connected with the fact that the decay into the $\Sigma(1385)$ and a pion occurs only in an s-wave and is described by one isotopic amplitude, owing to the quantum numbers of the $\Lambda(1520)$ resonance and the low kinetic energy of $\Sigma(1385)$. (J.F.P.)

29677 UNITARY STRUCTURE OF THE PARITY- AND STRANGENESS-CHANGING NONLEPTONIC WEAK INTERACTION. Lipmanov, E. M. JETP Lett. (USSR) (Engl. Transl.), 7: 81-4(Feb. 1968).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redakitsyu, 7: 108-10(Feb. 5, 1968).

It is shown that in the model of the unified electromagnetically weak interaction the assumption that the (V + A)-form strangeness-changing hadron currents in the nonleptonic current–current $|\Delta S| = 1$, CP-odd weak interaction makes it possible to determine the unitary structure of the latter, which is in satisfactory quantitative agreement with the experimental data on $K \to 2\pi$ decays and in general qualitative correspondence with the nonleptonic rule $|\Delta T| = \frac{1}{2}$ for all nonleptonic processes. (J.F.P.)

29678 CHIRAL DYNAMICS FOR PHOTO-HADRON AND WEAK INTERACTIONS. Iwao, Syurei (Tokyo Univ. of Education). Progr. Theor. Phys. (Kyoto), 39: 405-10(Feb. 1968).

Chiral dynamics for photo-hadron interaction and weak semileptonic decay of baryons are examined in detail. Weinberg's method is extended to the latter problem and leads to the effective Lagrangian containing the four-body semilepton decay of hyperons calculated before by the algebra of currents. The same Lagrangian also applies to the semileptonic decay of mesons in a proper interpretation of it. A generalization of the method to the weak hadronic decay is straightforward. (auth)

Strong (General)

Refer also to abstract 29752.

29679 QUARK STATE OF MATTER. Shishkin, G. V. Dokl. Akad. Nauk BSSR, 11: 995-6(Nov. 1967). (In Russian).

The possibility of the realization in nature of a quark state of matter in the core of superdense stars was considered for the case where the quarks appear as fermions. It was shown that even under conditions of supercompression when the energy relations show a possible stabilization of quark-fermions, matter prefers the baryon state, and the quark part amounts to only ~1/10 of the total mass of matter. (tr-auth)

29680 SU(3) SYMMETRY, EXCHANGE DEGENERACY, AND LORENTZ-POLE CLASSIFICATION OF CONSPIRATOR FAMILIES. Ahmadzadeh, Akbar (Arizona State Univ., Tempe). Phys. Rev. Lett., 20: 1125-7(May 13, 1968).

A classification of conspiring trajectories according to SU(3) symmetry, exchange degeneracy, and Lorentz symmetry is given. This classification gives rise to numerous experimental consequences. A few of such predictions are indicated. (auth)

29681 SUPERCONVERGENT DISPERSION RELATIONS. Oehme, Reinhard (Brookhaven National Lab., Upton, N. Y.). Ann. Phys. (N. Y.), 46: 347-63(Feb. 1968). (BNL-11714).

The more general aspects of the saturation problem for superconvergent dispersion relations are reviewed and discussed. It is found that complete sets of superconvergence conditions for forward amplitudes generally have solutions corresponding to higher collinear symmetries of the vertices. The saturation of mesonic superconvergence relations with infinite sequences of quark-antiquark states is considered in detail for forward and nonforward amplitudes. It is argued that, for sufficiently bounded amplitudes, the saturation of superconvergence conditions at a given value of t (e.g., $t = 0$ and a few derivatives at this point) with a finite number of resonances can be reasonable, approximate scheme for the calculation of coupling constants and masses. (auth)

29682 THE EXCITATION OF THE 6^1P_1 AND 6^3P_1 STATES OF MERCURY BY PROTON IMPACT. McConnell, J. C.; Moiseiwitsch, B. L. (Queen's Univ., Belfast). pp 50-6 of Heavy Particle Collisions. London, Institute of Physics and Physical Society, 1968.

From Conference on Heavy Particle Collisions, Belfast. See CONF-680415.

Regarding the mercury atom as a two-electron system with the orbitals determined using the Coulomb approximation, and employing intermediate coupling wave functions which allow for the spin–orbit interaction of the 6p electron mixing, the 6^1P_1 and 6^3P_1 states of mercury, and the oscillator strengths of the $6^1P_1 \to 6^1S_0$ 1850 Å line and the $6^3P_1 \to 6^1S_0$ 2537 Å line are calculated. The Born approximation is then used to find cross sections for the excitation of the 6^1P_1 and 6^3P_1 states of mercury by proton impact. (auth) (UK)

29683 CURRENT ALGEBRA, POLE DOMINANCE, AND MESON COUPLING CONSTANTS. Csikor, F.; Montvay, I. (Roland Eoetroes Univ., Budapest). Nucl. Phys., B5: 492-8(1968).

The Fubini–Halliday–Landshoff type sum-rules are applied in pole dominance approximation to current × meson × meson vertices. The first Weinberg relation is derived; the A1 → ρπ width and the charge radius of pion are calculated in agreement with experimental data. (auth)

Strong (Baryon No. = 0)

Refer also to abstract 29775.

29684 (DESY-68/10) ZUR ANWENDUNG DES STATISTISCHEN MODELLS MIT DREHIMPULSERHALTUNG. (Use of Statistical Models with Angular Momentum Conservation). van Keuk, Guenter (Hamburg Univ. (West Germany). Institut fuer Theoretische Physik (II)). Feb. 1968. 99p. (In German). Dep.

A statistical model with energy-momentum and angular-momentum conservation is described and discussed taking into account different masses, spins and isospins of the outgoing particles. The phase-spaces are evaluated approximately by the use of asymptotic expansions for large particle numbers. The probability of "fireball formation" is assumed to vanish at high energy for each partial wave as a consequence of the Lorentz contraction of the interaction volume. Describing fireball formation and decay separately, cross sections are derived for all central events. Including statistical ρ-production our numerical results are, in nearly all cases, in good agreement with the experimental data on $p\bar{p}$-annihilation into pions from 1.6 to 7.0 GeV/c. (auth)

29685 CLUSTER MODEL OF MESONS AND SQUARE MASS RELATION. Toyoda, Fumihiko (Kyushu Univ., Fukuoka). Progr. Theor. Phys. (Kyoto), 39: 537-8(Feb. 1968).

A square mass relation is obtained within the framework of the cluster model of mesons, in which the meson state is considered as a phonon-like collective mode of the baryon and antibaryon. (L.B.S.)

29686 CONSPIRACY RELATION FOR THE REACTION $N\bar{N} \to Y\bar{Y}$. Morita, Katsusada (Kyoto Univ.). Progr. Theor. Phys. (Kyoto), 39: 531-3(Feb. 1968).

A conspiracy relation for $N\bar{N} \to Y\bar{Y}$ is obtained from crossing relations and S- and t-channel helicity amplitudes, which is shown to be different from the conspiracy situation found in $N\bar{N} \to N\bar{N}$. (L.B.S.)

29687 EXPERIMENTAL FORMULA FOR MESON MASS. Schuster, K. (Univ., Jena, Ger.). Acta Phys. Pol., 33: 155-8 (Jan. 1968). (In German).

In connection with a new classification of mesons, an empirical formula for the meson mass was given. The formula is in agreement with the existing interval rules. The formula yields very good values for 23 mesons; six additional resonances are given as mass differences. The new classification is a modification of the Gell–Mann and Nishijima charge formula. (tr-auth)

29688 MASSES OF BOSONS WITH SPIN ONE UNIT AND THE ALGEBRA OF FIELDS. Iwao, Syurei (Tokyo Univ. of Education). Progr. Theor. Phys. (Kyoto), 39: 526-7(Feb. 1968).

It is shown that the application of Weinberg's sum rules to the determination of mass eigenvalues of vector and axial vector mesons can include the φ and D mesons by interpreting properly the Lagrangian assumed in the theory of field-current identities and the algebra of fields. U(3) symmetry is assumed in addition to the "form invariance" of the Lagrangian. As a consequence a simple relation is obtained between the masses of vector and axial vector mesons with the same unitary spin. (L.B.S.)

29689 ON Kπ RESONANCE STATES. Wu, Shang-Xian; Huang, Wu-chun; Xu, Bo-Wei. Chin. J. Phys. (Peking) (Engl. Transl.), 22: 710-13(Feb. 1967).

Translated from Wu Li Hseuh Pao, 22: 961-5(Aug. 1966).

The method of bootstrap dynamics is used to treat both K* and κ to determine the spin and parity of κ. In this method, taking K* to be a 1^- state, K*, κ, and ρ are used as input forces, and the self-consistent calculation is done for the two separate cases of κ being 0^+ and 1^-. From the self-consistency condition the size of the coupling constant is determined. From a comparison of the results the quantum numbers of κ can be determined. The Born amplitude produced by the three input particles and for the two cases and their contributions to the Kπ scattering amplitude are calculated. The self-consistency requirement is used to derive two sets of equations. (J.F.P.)

29690 ON THE RADIATIVE DECAY OF THE A_2 MESON. Sarker, A. Q. (Univ. of Islamabad, Rawalpindi, Pakistan). Nucl. Phys., B5: 560-6(1968).

The decay width $\Gamma(A_2 \to \pi + \gamma)$ is predicted by saturating with single-particle intermediate states, a sum rule obtained from consideration of the process $\pi \to \pi^0 l\nu\gamma$. Its relationship is discussed with the question of subtraction in the dispersion relation of a certain amplitude for the process $\pi \to l\nu\gamma$. In case of subtraction, the decay $A_2 \to \pi\gamma$ can put restrictions on the values of the parameter which appears in A_1–ρ–π system. (auth)

29691 QUARK MODEL RESULTS FROM WEINBERG'S SPECTRAL FUNCTIONS SUM RULES. Dar, A.; Weisskopf, V. F. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Phys. Lett., 26B: 670-3(Apr. 29, 1968).

It is shown that quark model results for meson decay rates can be obtained using Weinberg's spectral function sum rule. (L.B.S.)

29692 SOFT-PHOTON EMISSION APPROACH TO THE DECAYS $\omega, \varphi, \rho \rightarrow 2\pi\gamma$. Pascual, R.; Srivastava, P. P. (International Centre for Theoretical Physics, Trieste, Italy). Nuovo Cim., 54A: 835-9(Apr. 21, 1968).

The hypothesis of PCTC for the electromagnetic current is used to calculate the rates of the decays $\omega, \varphi \rightarrow 2\pi\gamma$ and $\rho \rightarrow 2\pi\gamma$. (auth)

29693 STRANGENESS-EXCHANGE PROCESSES IN THE QUARK MODEL. Gorczyca, B. (Jagellonian Univ., Krakow). Acta Phys. Pol., 33: 471-93(Mar. 1968).

Two-body strangeness-exchange processes, with or without resonance production, are discussed in the framework of the generalized quark model. Relations between the cross sections and spin density matrix elements are derived and compared with the experimental data. The comparison shows a reasonable agreement for the relations between the cross sections, except for processes involving Σ-hyperons. Also the density matrix elements seem to be correctly described by the model. (auth)

29694 SUPERCONVERGENCE SUM RULES FOR $N + \bar{N}^* \rightarrow \pi + \pi$. Bartl, A.; Widder, F. (Univ., Tuebingen, Ger.). Nuovo Cim., 54A: 1009-12(Apr. 21, 1968).

Superconvergence sum rules for $N + \bar{N}^* \rightarrow \pi + \pi$ are used to obtain relations for ρNN^* and πN^*N^* couplings. The results for the ρNN^* coupling are in agreement with SU(6), where as the πN^*N^* couplings disagree with U(6,6). (L.B.S.)

29695 USE OF SINGLE-PION PRODUCTION TO REMOVE AMBIGUITIES IN PARTIALLY CONSERVED AXIAL-VECTOR CURRENT AND CURRENT-ALGEBRA PREDICTIONS ON π-π SCATTERING. Olsson, M. G.; Turner, Leaf (Univ. of Wisconsin, Madison). Contract AT(11-1)-881. Phys. Rev. Lett., 20: 1127-30(May 13, 1968). (COO-881-161).

It is shown that the ambiguities present in the current-algebra and partially conserved axial-vector current model of low-energy π-π scattering are the same as those in the single-pion production amplitude. The experimental data strongly support the Weinberg formulation. (auth)

29696 VECTOR-MESON EXCHANGE AND CONTINUATION IN THE ANGULAR MOMENTUM OF THE $\pi\pi$ AMPLITUDE. Bassetto, A.; Campogalliani, P.; Paccanoni, F. (Univ., Padua. Istituto Nazionale di Fisica Nucleare, Padua). Nuovo Cim., 54A: 897-918(Apr. 21, 1968).

The continuation in the angular momentum of the I = 1 odd signature, $\pi\pi$ amplitude is studied for negative values of the c.m. energy squared in a model with the forces due to the exchange of an undamped vector meson. The corresponding singular N/D equations were solved by means of the Wiener-Hopf technique and detailed numerical results were obtained for the denominator function when the angular momentum varies between zero and one. Indications are found on the behavior of the ρ trajectory in contrast with the predictions of preceding dynamical models. (auth)

29697 A_1-MESON DECAY IN THE QUARK MODEL. Dillon, G.; Giannini, M. M. (Univ., Genoa). Nuovo Cim., 54A: 937-44(Apr. 21, 1968).

The process $A_1 \rightarrow \rho\pi$ is studied by means of the nonrelativistic quark model, in which the A_1-meson is considered as a $^3P_1$ state of the $q\bar{q}$ couple. The result is that the decay matrix element consists of a superposition of S and D waves, with comparable and related amplitudes. The analysis of the Dalitz plot relative to the three final pions could detect the interference between the two waves and supply a good test of the A_1 structure. (auth)

Strong (Baryon No. = 1)

Refer also to abstracts 29693 and 29898.

29698 (AECD/TP-22) K-MESON NUCLEON FORWARD DISPERSION RELATIONS AND THE EVALUATION OF THE COUPLING CONSTANTS. Ara, Gulshan; Harun-Ar Rashid, A. M. (Atomic Energy Centre, Dacca (Pakistan)). Oct. 1967. 16p. Dep.

The forward scattering dispersion relations for K-meson nucleon system are evaluated with a view to determining the coupling constants. Two different forms of dispersion relations as proposed by Igi are particularly convenient for this purpose. Using the most recent data on total cross sections and the zero-range scattering lengths in the evaluation of the unphysical continuum, reasonable values of the coupling constants are obtained. (auth)

29699 (INR-P-881/VI/PH) AN APPLICATION OF THE SATZ SUM RULES TO THE HIGH MULTIPLICITY PROCESSES. Hofmokl, T.; Szeptycka, M. (Institute of Nuclear Research, Warsaw (Poland)). 1968. 8p. Dep.

The relation which follows from the Satz additive quark model between cross sections for the reactions $\pi p \rightarrow N(k+1)\pi$ and $pp \rightarrow NN\,k\pi$ is found to be in agreement with experimental data for k = 4 and k = 5. (auth)

29700 (ORNL-tr-1800) INTRANUCLEAR CASCADES WITH MANY-PARTICLE INTERACTIONS. Artykov, I. Z.; Barashenkov, V. S.; Eliseev, S. M. Translated for Oak Ridge National Lab., Tenn., from report JINR-P2-3604. 32p. Dep. CFSTI. JCL $3.60 fs, $1.16 mf.

Properties of many-particle interactions are studied by comparing the results of a cascade calculation with known experimental data on the interactions of pions and nucleons with various atomic nuclei in a wide energy range. The essential details of the calculations are described. (L.B.S.)

29701 APPLICATION OF THE DOUBLE PERIPHERAL MODEL TO THE REACTION $K^+p \rightarrow K^+\pi^+n$ AT 3 GeV/c. Gislen, L. (Univ. of Lund, Sweden). Nuovo Cim., 54A: 919-36(Apr. 21, 1968).

An attempt is made to reproduce the experimental differential cross sections of the reaction $K^+p \rightarrow K^+\pi^+n$ assuming the validity of the double peripheral model. Double vector-meson exchange (ρ,ω) has to be included to account for the small slope in $d\sigma/dt$ where $-t$ is the momentum transfer between the two nucleons. Restrictions on the coupling constants and approximate values of the other parameters are obtained from the calculations. The analysis indicates, however, that mechanisms other than the double peripheral model probably contribute significantly to this process, at least in the energy region considered here. (auth)

29702 BARYON STATE OF MATTER IN THE POST-π-MESON PHASE. Shishkin, G. V. (Inst. of Nuclear Power Engineering, Minsk). Dokl. Akad. Nauk BSSR, 11: 798-801(Sept. 1967). (In Russian).

At baryon densities of matter $>10^{41}$ cm^{-3}, the separate baryon states lose their individuality, and matter becomes an ensemble of indistinguishable nuclei submerged in a field of π-mesons. If the nuclei are identical, it is possible to conceive a model of a superdense degenerate gas. The threshold densities of matter are calculated for all the well-known baryon states (nucleons, hyperons, resonances). The numerical results are listed in tabular form. With an increase in the density of matter, more highly excited baryon states which are unknown at present should appear in a star with the model of a superdense degenerate gas adopted. With increasing particle density the lighter states are replaced by heavier states, as takes place in the evolution of an ordinary star. (TTT)

29703 CONSISTENCY CONDITION FOR $|\Delta S| = 1$ CURRENTS. Agarwal, B. K.; Watal, C. (Allahabad Univ., India). Nuovo Cim., 54A: 849-55(April. 21, 1968).

A consistency condition for $|\Delta S| = 1$ currents was derived by considering $K^-\Xi^0$ scattering. (auth)

29704 ON BARYON OCTETS AND $N^*_{\frac{1}{2}}(1400)$. Kiang, D.; Sugano, R. (Dalhousie Univ., Halifax, Can.). Progr. Theor. Phys. (Kyoto), 39: 538-40(Feb. 1968).

The classification of octet baryons and possible assignments of the Roper resonance $N^*_{\frac{1}{2}}(1400)$ within the framework of the quark model are briefly reviewed. A model is considered which mixes two octets, and which results in the observed mass difference between the octet including the N and the one including $N^*_{\frac{1}{2}}(1400)$. The other excited baryon states predicted by the model are $\Lambda^*(1576)$, $\Sigma^*(1653)$ and $\Xi^*(1778)$. (L.B.S.)

29705 ON THE POSSIBILITY OF MEASURING THE $\Sigma^0-\Lambda$ TRANSITION MAGNETIC MOMENT IN THE REACTION $\pi^-p \rightarrow \Lambda K^0\gamma$. Kondratyuk, L. A.; Ponomarev, L. A.; Zakharov, V. I. (Inst. for Theoretical and Experimental Physics, Moscow). Nucl. Phys., B5: 463-78(1968).

It is shown that the magnetic moment of the $\Sigma^0-\Lambda$ transition $\mu_{\Sigma\Lambda}$ may be determined measuring the cross section of the reaction $\pi^-p \rightarrow \Lambda K^0\gamma$ near the threshold of Σ^0 production. If the initial energy is 1–3 MeV below the threshold, the cross section is shown to be crucially dependent on the magnitude of $\mu_{\Sigma\Lambda}$. The cross section value is of the order of 10–100 nb. The momentum of the initial π-meson should be fixed with the accuracy of about 1 MeV. (auth)

29706 PION PRODUCTION IN PION–PROTON COLLISIONS AT 4 TO 11 GeV/c MULTIPLICITY DISTRIBUTION AND A POSSI-

BLE QUALITATIVE INTERPRETATION OF THE BARYON ANGULAR DISTRIBUTION. Bartke, J.; Czyzewski, O. (Inst. of Nuclear Research. Krakow). Nucl. Phys., B5: 582-92(1968).

It is shown that the relative probabilities of different charge configurations in multiple pion production by pions on protons are consistent with the predictions of the statistical model. Therefore this model can be used in order to calculate the distribution of the multiplicity of produced pions, independent of their charge. The multiplicity distributions are presented for 4 GeV/c π^+, 8 GeV/c π^+ and 10 GeV/c π^-. On the basis of the c.m. angular distribution of the baryon it is proposed to consider pion-proton collisions as composed of "peripheral" and "statistical" parts. (auth)

29707 REAL TO IMAGINARY RATIO OF THE FORWARD SCATTERING AMPLITUDE IN CHARGE EXCHANGE PROCESSES. Fujimura, Kimio; Kobayashi, Tsunehiro; Ohba, Ichiro (Waseda Univ., Tokyo). Progr. Theor. Phys. (Kyoto), 39: 530-1(Feb. 1968).

The real to imaginary ratios of the forward scattering amplitudes for the charge exchange scattering with Y = 0 are presented. Only charge independence is assumed for the $\pi^-p \to \pi^0n$ reaction. Results for the reactions $\pi^-p \to \eta_8 n$, $K^-p \to \bar{K}^0n$, and $K^+n \to K^0p$ are obtained under the assumption of the octet dominance and SU(3) symmetry. (L.B.S.)

29708 REGGE SINGULARITIES IN FORWARD πN CHARGE EXCHANGE: AN ANALYSIS WITH A NEW FAMILY OF SUM RULES. Della Selva, A. (International Centre for Theoretical Physics, Trieste, Italy); Masperi, L.; Odorico, R. Nuovo Cim., 54A: 979-82(Apr. 21, 1968).

A larger family of sum rules obtained by generalizing the finite-energy sum rules for integer moments to continuous ones is considered. The sum rules are used systematically, treating the results with a best-fit procedure, in order to determine the relevant Regge parameters. The technique is applied in particular to the forward πN charge exchange giving the result that, once the background is subtracted, no other Regge contribution is present besides the ρ-pole. (auth)

29709 SELF-CONSISTENT CALCULATION OF THE N_{11}^* PARAMETERS. Gastmans, R.; Halzen, F. (Univ. of Louvain, Belg.). Nuovo Cim., 54A: 1013-15(Apr. 21, 1968).

A ρ-type bootstrap of the N_{11}^* (1400) or the so-called Roper resonance associated with a single N($\pi\pi$) channel is discussed. A single-channel calculation is performed, taking into account only the σ(720) resonance. (L.B.S.)

29710 SEMI-PHENOMENOLOGICAL CALCULATIONS WITH PARTIAL-WAVE DISPERSION RELATIONS. Alcock, J. W.; Burkhardt, H.; Lyth, D. H.; McCauley, G. P. (Univ. of Birmingham, Eng.). Nuovo Cim., 54A: 956-75(Apr. 21, 1968).

The "variational" method of solving partial-wave dispersion relations suggested by Donnachie and Hamilton is discussed and shown to be equivalent to fitting the left-hand cut of a unitary trial function to that obtained from crossing over the low-energy physical region. A repetition of their numerical calculation for the N_{33}^* gives different results which are in close accord with those obtained by the N/D method; a two-parameter trial function is completely determined, but gives a solution with no resonance. A three-parameter function gives a solution with one-parameter ambiguity; when the resonance position is given, the width and shape, which correspond to the effective position and strength of the nearby left-hand cut, are determined in agreement with experiment. The solutions are discussed and related to the N/D method. (auth)

29711 QUARK MODEL OF THE BARYONS. Shapiro, Joel Alan. Ithaca, N. Y., Cornell Univ., 1967. 58p.
Thesis.

The ever-growing spectrum of baryon states has made imperative an understanding of the relations among particles of different spins. A phenomenological calculation of "coupling constants" from observed decay widths gives a convenient measure of the interaction. An analogy with electromagnetic decays of a charged harmonic oscillator is given, suggesting the potential power of an algebraic or group theoretic approach. A model is developed in which the baryons are the states of a three-quark system bound by zero natural length springs. The spring constants and the masses are assumed independent of the type of quark, making the theory SU(6) invariant. The states are classified according to their symmetry under permutations, and the totally symmetric states are considered as possibilities for the known baryons. With one additional assumption it is possible to relate the decay widths of the nonstrange baryons. This assumption may be either that the pion source is generated individually by each quark, independent of its motion, or that the PCAC hypothesis applies. Either assumption gives a knowledge of the commutation relations necessary to relate coupling constants for various particles along a Regge trajectory. These results agree well with the data. Taken seriously, the PCAC hypothesis and the "off-shell limit" give the electromagnetic and pionic nucleon form factors. The former is in qualitative agreement with experiment. (Disser. Abstr.)

29712 SOLUTIONS OF A MODEL FIELD THEORETICAL EQUATION FOR THE NEUTRON–PROTON MASS DIFFERENCE. Gaisser, Thomas Korff. Providence, Brown Univ., 1967. 93p.
Thesis.

The neutron-proton mass difference is calculated to order e^2 within the framework of a field theoretical model. The model is equivalent to a linear integral equation for the difference between the neutron and proton self-energy functions. The inhomogeneous term in this equation is the elastic contribution to the difference between the neutron and proton mass operators; calculation of this elastic contribution alone gives the wrong sign for the mass difference. A method is developed to solve the integral equation numerically. When certain assumptions are made for the spectral representations of the self-energy functions, both elastic and exact, the correct sign is found for the neutron-proton mass difference. The calculation provides a qualitative insight into a mechanism of electromagnetic origin which may be responsible for the observed n-p mass difference. (Disser. Abstr.)

29713 UNITARITY–ANALYTICITY EQUATIONS FOR ELASTIC PION–NUCLEON SCATTERING: A NUMERICAL SOLUTION. Boccio, John Raymond. Ithaca, N. Y., Cornell Univ., 1967. 79p.
Thesis.

The problem of elastic pion-nucleon scattering is considered. Using the elastic unitary approximation together with Mandelstam analyticity and the crossing principle, an approximation scheme was devised which enabled one to derive a set of four coupled linear integral equations for the imaginary parts of the u-channel absorptive parts. Meromorphy in the J-plane or Regge asymptotic behavior was then included. A numerical solution of these equations was carried out. The results were very encouraging in the sense that output trajectories were produced which have some interesting properties, i.e., one was able to generate trajectory functions which easily rise to values of Re $\alpha_\Delta(u) \approx 3/2$ and possess a shape which resembles the conventionally assumed form. (Disser. Abstr.)

29714 ANALYSIS OF $\pi^+p \to \pi^0N^{*++}$ REACTION BY REGGE POLE MODEL. Iwaki, Atsuko (Rikkyo Univ., Tokyo). Progr. Theor. Phys. (Kyoto), 39: 394-404(Feb. 1968).

The reaction $\pi^+p \to \pi^0N^{*++}$ is studied using a ρ Regge pole exchange model. The ρ trajectory obtained by the analysis of elastic and charge exchange scattering is used for πN and KN. The analysis starts from two invariant amplitudes in close connection with the magnetic coupling for the ρNN* vertex. The residue functions are determined in order to reproduce the angular distribution at 3.54 GeV/c. Then the angular distributions at 2.75 GeV/c and 8.0 GeV/c are in reasonably good agreement with the data. The distribution of the Treiman-Yang angle of N* decay is also consisten with the data. (auth)

Strong (Baryon No. ≥ 2)

Refer also to abstract 30079.

29715 (DESY–68/9) A CALCULATION OF THE ELASTIC N–N PHASE SHIFTS USING STRONG COUPLING FIELD MESON THEORY. Wagner, Siegfried (Hamburg Univ. (West Germany). Institut fuer Theoretische Physik (II)). Feb. 1968. 19p. Dep.

Wentzel's strong-coupling solutions of the fixed-source meson field theory derive the nucleon isobars in pion-nucleon interaction. The isobars are also relevant as intermediate states in nucleon-nucleon interaction. If only the lowest ones are included, the multichannel Schrödinger equation can be solved exactly, using Fierz's matrix representation of the strong-coupling solutions. In addition a core potential of Wigner type can be derived for small separations of the sources; this potential is idealized as a hard core of about .55 fermis. Contrary to previous calculations of A. Houriet et al., all N_{33}^* intermediate states are included. Good agreement is obtained for the S-wave phase shifts. All other phase shifts are in qualitative agreement with experiments, except for triplet P. At high energies deviations were established, which indicate that a short range spin–orbit potential is missing. (auth)

29716 AN IMPULSE MODEL THEORY OF π-^{4}He SCATTERING. Block, M. M.; Koetke, D. (Northwestern Univ., Evanston Ill.). Nucl. Phys., B5: 451-62(1968).

An impulse model description of π-^{4}He scattering into the channels a) $\pi^+ + {}^4He \to \pi^+ + {}^4He$, b) $\pi^+ + {}^4He \to$ all π^+, c) $\pi^+ + {}^4He \to$ all π^0 was made. Input data to the calculation consist of π-nucleon phase shifts, the r.m.s. nuclear radius of the α particle, and the absorption cross section for the reaction $\pi + {}^4He \to 4N$. The elastic channel (a) was compared with experimental data at 85 MeV/c and is in excellent agreement with experiment. (auth)

29717 COVARIANT THEORY OF THE PIONIC DISINTEGRATION OF THE DEUTERON. Schiff, D.; Tran Thanh Van, J. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Nucl. Phys., B5: 529-59(1968).

The pionic disintegration of the deuteron and its inverse process are studied in a covariant theory from threshold to 300 MeV pion kinetic energy. The singularity structure of the scattering amplitude as found from box diagrams makes it possible to select the leading contributions that come from the nucleon pole, the deuteron structure and the NN and NNπ intermediate states. The latter is treated as an NN* state where N* is the (3,3) pion nucleon resonance. Dispersion relations are written for partial wave amplitudes and the contribution of the NN* state to unitarity is explicitly calculated, taking into account the spin and the unstability of N*. A detailed comparison in the medium energy region shows a good agreement with the existing data. (auth)

29718 HIGH-ENERGY BEHAVIOR OF AMPLITUDES AT ZERO SCATTERING ANGLE. Mickens, R. E. (Vanderbilt Univ., Nashville). Nuovo Cim., 54A: 995-8(Apr. 21, 1968).

The consequences of cuts in the angular-momentum plane and the contribution to the asymptotic behavior of the elastic-scattering amplitude in the forward direction are discussed. (L.B.S.)

29719 THE REAL PART OF ELASTIC p-d SCATTERING AMPLITUDE AT 1 GeV. Chernev, H. M.; Markov, P. K. Compt. Rend. Acad. Bulg. Sci., 20: 417-19(1967).

The elastic p-d scattering at 1 GeV in the small angle region was investigated by means of the Sviridov method (B. Bekker et al., Int. Conf. High Energy Phys. at CERN, 1962, p. 585). While the preliminary results may be found elsewhere (Compt. Rend. Acad. Bulg. Sci., 19, 1966, 875), tabulated data reflecting a 40% increase in statistics mainly in the region of largest scattering angles are presented. A theoretical study of the differential cross section curve indicates that it agrees with the dispersion relations prediction of A. A. Carter and D. V. Bugg (Phys. Lett., 20, 1966, 203). (JPRS)

29720 ANALYTICITY PROPERTIES OF THE MESON–DEUTERON ELASTIC-SCATTERING AMPLITUDES AT LOW ENERGY. Ando, Fujio. Providence, Brown Univ., 1967. 194p.

Thesis.

The analyticity properties of the meson-deuteron elastic-scattering amplitudes were studied at low energy. The loosely bound nature of the deuteron results in small anomalous thresholds of the amplitudes in the t-channel and justifies the use of selected Feynman diagrams in the determination of general analyticity properties of the amplitudes. The impulse approximation, the binding corrections and the multiple-scattering terms are defined in terms of both triangle and box diagrams, and the dispersion relations with fixed s for these terms are derived by the method of analytic continuation with respect to the deuteron mass and with respect to s. It is found that the anomalous parts of the deuteron-baryon vertices play important roles in the derivation of the dispersion relations and that the double-scattering amplitudes have no complex singularities. The general method was applied to a determination of angular distributions for π^+d and K^-d elastic scattering. In the former case, the binding corrections due to $N^*{}_{3/2}$ is the main correction to the impulse approximation. In the latter case, the impulse approximation was determined in terms of the K^-N scattering amplitudes which are approximated by two complex poles, and is in good agreement with existing phenomenological calculations. Finally, a possibility of applying (coupled) generalized unitarity to the meson-deuteron elastic scattering amplitudes has been explored. The impulse approximation can be defined in such a way that a correspondence to the phenomenological theory is apparent, if the meson-meson interaction is ignored. (Disser. Abstr.)

29721 ABSORPTION OF STOPPED K^- MESONS BY LIGHT NUCLEI. Cheon, Il-tong (Kyoto Univ. Kobe-Gakuin Coll., Japan). J. Phys. A, 1: 350-7(May 1968).

The non-mesonic and non-radiative capture processes of K^- mesons in light nuclei, $K^- + 2N \rightarrow \Lambda + N$ and $K^- + 2N \rightarrow \Sigma + N$, were investigated using a pair-absorption model. It is shown that the ratio of the capture rate by the relative D-state pair to that by the relative S-state pair is very sensitive to the short-range nuclear correlations. (auth)

Particle Invariance Principles and Symmetries

General

Refer also to abstracts 29754, 29970, 30084, and 30106.

29722 BROKEN SYMMETRY AND NONINVARIANCE GROUPS. Lanik, J. (Inst. of Physics, Bratislava). Nucl. Phys., B5: 523-8(1968).

A method is suggested for solving the dynamical problem of the non-maximally degenerate and non-relativistic quantum mechanical systems within the framework of the group theory. As an example, a system with the interaction of the form $V(r) = \frac{1}{2}m\omega^2r^2 + (a/r^2)$, $a \geq 0$, is treated. In this case the group SO(3) $\otimes$ SO(2,1) plays the role of the non-invariance group. The unitary irreducible representations are found. They contain all bound-state levels of our model. The exact formula of the energy spectrum is deduced in the framework of this group and its representations. (auth)

29723 CLEBSCH–GORDAN COEFFICIENTS OF THE GROUP SU(3). Jasselette, P. (Univ., Liege). Bull. Soc. Roy. Sci. Liege, 36: 654-8(1967). (In French).

Kramers' symbolic method is used to derive an algorithm allowing the explicit determination of any Clebsch–Gordan coefficients for the group SU(3). (auth)

29724 OPERATOR METHOD FOR THE ADDITION OF TWO ANGULAR MOMENTA BY SYMMETRIZING THE PRODUCT OF n SPIN FUNCTIONS. Ansari, S. M. Razaullah (Univ., Tuebingen, Ger.). Forschr. Phys., 15: 707-27(1967).

A general expression of Clebsch-Gordan coefficients is derived by means of de Broglie-like méthode de fusion: the second angular momentum is added to the first in n steps of half each, the maximum symmetric composition of the n spin functions being taken into account explicitly. The procedure is operatorial. Group-theoretically speaking the irreducible representations of the direct product of two irreducible representations of the rotation group are realized via symmetric group S_n with the aid of projection operators (equivalent to Young's symmetrizers). The decomposition of the representations of S_n therein is performed inductively by utilizing the chain of subgroups: $S_n \supset S_{n-1} \ldots \supset S_2 \supset S_1$. (auth)

29725 PATTERN CALCULUS FOR TENSOR OPERATORS IN THE UNITARY GROUPS. Biedenharn, L. C. (Duke Univ., Durham, N. C.); Louck, J. D. Commun. Math. Phys., 8: 89-131 (1968). (LA-DC-9214).

For a large class of tensor operators in U(n), a surprisingly simple diagrammatic calculus of patterns is shown to exist; to each operator of this class a pattern may be assigned in terms of which the complete algebraic formula for all matrix elements may be read off directly. The class of operators includes all fundamental, elementary and external Wigner operators in all U(n). Application of the pattern calculus toward the explicit determination of all tensor operators is discussed. (auth)

29726 QUASI-BINOMIAL REPRESENTATIONS OF CLEBSCH-GORDAN COEFFICIENTS. Ansari, S. M. Razaullah (Univ., Tuebingen, Ger.). Fortschr. Phys., 15: 729-51(1967).

An operator method for the addition of two angular momenta was previously described, and a general expression for the Clebsch–Gordan coefficients was set up. The formula for the Clebsch–Gordan coefficients was given in terms of generalized powers which appear automatically as a result of application of the n projection operators. It is shown that the importance of the generalized powers is actually due to their converting the summation, occurring in a Clebsch–Gordan expression, into a quasi-binomial expansion, which makes the summation part of the Clebsch–Gordan expression very neat and concise as well as numerically simplified. (J.F.P.)

29727 RECURSION RELATIONS FOR THE 3-j SYMBOLS. Micu, M. (Joint Inst. for Nuclear Research, Dubna, USSR). Nucl. Phys., A113: 215-20(1968).

The realization of the SU(2) group by boson operators gives a simple definition for the 3-j symbols as a scalar product for states with three different bosons. Manipulation of the boson operators from one part of the scalar product to another gives recursion relations for the 3-j symbols. By taking into account the symmetries of the 3-j symbols, there are six independent recursion relations, but this number is reduced to two by the new symmetries discovered by Regge. (auth)

29728 REDUCTION OF RELATIVISTIC WAVEFUNCTIONS TO THE IRREDUCIBLE REPRESENTATIONS OF THE INHOMOGENEOUS LORENTZ GROUP. PART II. ZERO-MASS COMPONENTS. Moses, H. E. (Massachusetts Inst. of Tech., Lexington). J. Math. Phys. (N. Y.), 9: 16-31(Jan. 1968).

It was previously shown how wavefunctions which transform in a relativistic manner in configuration space can be expanded in terms of amplitudes, which for nonzero mass transform like the wavefunctions for irreducible representations of the proper, orthochronous, inhomogeneous Lorentz group. A simple algorithm was given to obtain the expansion. The results are extended to include

zero-mass amplitudes. It is shown that for wavefunctions which are required to transform under the homogeneous Lorentz group such that the matrices which involve the spinor indices are finite dimensional, the zero-mass amplitudes transform under nonunitary representations of the inhomogeneous Lorentz group. However, it is possible to split up each such nonunitary representation into a part which corresponds to a unitary representation for finite spin and into a part which corresponds to an unphysical change of wavefunction. As examples of the technique, wavefunctions which transform as an antisymmetric real tensor (i.e., as an electromagnetic field) as a four-vector with and without the Lorentz condition, and as a Dirac spinor are considered. The results offer interesting contrasts with the previous reductions where only nonzero-mass components were considered. It is shown that this expansion, when applied to the solution of Maxwell's equations, leads to an expansion in terms of photon wavefunctions and that the unphysical change of wavefunction is zero. For a real vector potential with the Lorentz condition (i.e., the electromagnetic vector potential), the expansion corresponds to the sum of an expansion in terms of photon wavefunctions and a wavefunction which sets the gauge of the vector potential. The nonphysical part of the transformation of the electromagnetic vector potential is merely a gauge change. Finally, solutions of the massless Dirac equation are expanded in terms of wavefunctions for massless particles of spin $\frac{1}{2}$ for which the nonphysical part of the change is zero. It is also shown how invariant inner products are to be introduced, how negative-energy representations can be replaced by positive-energy representations ("antiparticles"), and the connection with the usual canonical formalism is shown. Finally, second quantization of the theory is given. (auth)

29729 UNITARY REPRESENTATIONS OF THE HOMOGENEOUS LORENTZ GROUP IN AN O(2,1) BASIS. Mukunda, N. (Syracuse Univ., N. Y.). J. Math. Phys. (N. Y.), 9: 50-61(Jan. 1968).

Unitary irreducible representations of the homogeneous Lorentz group, SO(3,1), belonging to the principal series and containing integral angular momenta, are reduced with respect to the subgroup SO(2,1). It is found that the representation $\{j_0,\rho\}$ of SO(3,1), where j_0 is a non-negative integer and ρ a real number, contains each representation of SO(2,1) of the continuous class (nonexceptional and integral) twice, and each of the discrete representations $D_k^{(\pm)}$ of SO(2,1) once, for $k = 1,2 \ldots, j_0$. The latter representations are absent for $j_0 = 0$. It is shown that the basis states of the representation $D_k^{(\pm)}$ (for $k \geq 2$) lie in the domain of those generators of SO(3,1) that are outside the SO(2,1) subalgebra, while the states of the representations $D_1^{(\pm)}$ do not lie in this domain. It is further shown that from the point of view of the nature of this domain, the representations $D_1^{(\pm)}$ of SO(2,1) are very intimately connected to the continuous class representations of SO(2,1), and that these two discrete representations act as a bridge between the remaining discrete representations on the one hand, and the continuous class representations on the other. (auth)

29730 FORMALISME LAGRANGIEN ET LOIS DE SYMETRIE. (Lagrangian Formalism and Symmetry Laws). Gourdin, M. Cours et Documents de Mathematiques et de Physique. New York, Gordon and Breach, Science Publishers, Inc., 1967. 107p. $10.00 cloth; $6.00 paper.

The conservation laws associated with continuous and discrete symmetries are studied, covering the formalism of quantum field theory. The work is performed in two spaces, in the first the considered transformation is defined, for example space–time or internal symmetry space, in the second, field operators act and it is called the Hilbert space of physical states. Two kinds of conservation laws are found: exact conservation laws, which have a universal character and are consequences of an exact symmetry of the total Lagrangian and approximate conservation laws which are connected with a particular type of interaction and are consequences of an exact symmetry of only one part of the total Lagrangian. The study of continuous transformations is made using a Schwinger technique in which a principle of action permits a representation to be obtained in the Hilbert space of infinitesimal generators of the transformation. Also the laws of discrete symmetries are studied representing space reflection, time reflection, and a conjugation of their product. (J.F.P.)

29731 SOME HIGHER-DIMENSIONAL ASPECTS OF ELEMENTARY PARTICLE SYMMETRIES. De Vos, Jacobus Adrianus. Amsterdam, Univ. of Amsterdam, 1967. 53p.

Thesis.

External as well as internal symmetries are considered. For both symmetries a higher-dimensional symmetry group is proposed, which suggests a higher-dimensional aspect of these symmetries. For the external symmetries the inhomogeneous de Sitter group is proposed, whereas for the internal symmetries the eight-dimensional rotation group is suggested. Wave equations for massless particles, the five-dimensional aspect of free particle motion, and the eight-dimensional aspect of internal symmetries are discussed. (J.F.P.)

29732 AXIAL VECTOR RENORMALIZATION CONSTANT FROM SU(4) CURRENT ALGEBRA. Pattnaik, Mamata (Saha Inst. of Nuclear Physics, Calcutta). Ann. Phys. (N. Y.), 46: 317-25(Feb. 1968).

A set of relations among the reduced matrix elements of current operators is obtained by suitably choosing a set of intermediate states in the SU(4) commutator algebra of currents. These relations when solved give a value for axial vector renormalization constant $g_A = 1.22$, which is quite close to the experimental value $g_A = 1.18$. (auth)

Applications (Electromagnetic and Weak)

29733 (ISS–68/3) CP-VIOLATING WEAK CURRENTS. Maiani, L. (Istituto Superiore di Sanita, Rome (Italy). Laboratori di Fisica). Jan. 20, 1968. 11p. Dep.

A theory in which CP is violated through second class axial currents is discussed. These currents are given a suitable algebraic structure so as to maintain the leptons–hadrons symmetry in leptonic processes. CP violations are then described by a universal angle ϕ, to be determined from experiments. Implications for leptonic and nonleptonic processes are discussed. (auth)

29734 VECTOR-CURRENT SUM RULE AND THE BROKEN MAGNETIC MOMENT OF THE Σ^+. Walsh, T. F. (Univ. of California, Berkeley). Nuovo Cim., 54A: 945-56(Apr. 21, 1968). (UCRL-17704).

A familiar vector-current sum rule of the Fubini-Furlan-Rossetti type is presented, and a model for the continuum corrections evolved. The symmetry breaking is introduced in a simple way by coupling the spurion in the sum rule to the baryon line in the graphs which contribute to the continuum terms. The decuplet does not contribute in this low-energy model. The correction terms turn out to be typically a few tenths of a magneton. The result for the Σ^+ moment, which depends on the D/F ratio, is for the usual choice of this ratio, $\mu^T(\Sigma^+) = 2.6$ nuclear magnetons. (auth)

29735 VIOLATION OF CP INVARIANCE IN WEAK INTERACTIONS. Swank, Lowell James. Urbana, Ill., Univ. of Illinois, 1967. 77p.

Thesis.

A new theory of nonleptonic weak interactions based on neutral F-spin currents of the SU_3 current algebra is presented. Both CP conserving and CP violating nonleptonic processes are generated by the same primary interaction. This interaction is used to calculate the s-wave amplitudes of hyperon nonleptonic decays, the $K_1^0 \rightarrow 2\pi$ decay rate and the decay rate of the CP violating process $K_2^0 \rightarrow 2\pi$. The neutron electric dipole moment, which depends on the violation of space-reflection invariance and of time-reversal invariance, is also calculated. It is found that in this theory the selection rule $\Delta S \neq \pm 2$ has as a consequence the Gell-Mann-Okubo mass formulas and the F/D ratios for both the axial vector current and the meson–baryon strong interactions. (Diss. Abstr.)

29736 SCHWINGER'S CHIRAL DYNAMICS AND THE PION MASS DIFFERENCE. Fairlie, D. B.; Yoshida, K. (Univ. of Durham, Eng.). Ann. Phys. (N. Y.), 46: 326-34(Feb. 1968).

Schwinger's scheme of chiral dynamics is reviewed and elaborated. An explicit form of the generators of his chiral algebra is found, and with its help the relation of this work to the σ model is elucidated. The pion mass difference and the η-decay rate are calculated on the assumption that only the isospin subgroup of Schwinger's chiral group is broken by electromagnetic interactions. (auth)

Applications (Strong)

29737 (KFKI–5/1968) MASS FORMULA IN BROKEN SL(2,C) AND ITS APPLICATION TO THE NUCLEON AND DELTA REGGE TRAJECTORIES. Domokos, G.; Koevesi-Domokos, S.; Suranyi, P. (Magyar Tudomanyos Akademia Kosponti Fizikai Kutato Intezete, Budapest). Apr. 10, 1968. 9p. Dep.

Consequences of a Regge-trajectory generating algebra SL/2,C/ are explored at nonvanishing energy. Nucleon and delta trajectories satisfy a second-order "mass formula" remarkably well. (auth)

29738 SEMI-STRONG C VIOLATION WITH $\Delta I = 3$. Marx, G.; Suranyi, P. (International Centre for Theoretical Physics, Trieste, Italy). Nuovo Cim., 54A: 856-61(Apr. 21, 1968).

The possibility of detecting the presence of a C-violating strangeness-conserving interaction with a $\Delta I = 3$ selection rule is studied. The estimated charge asymmetries in several-boson

decays and proton-antiproton annihilation processes are given. (auth)

29739 THE EXPERIMENTAL TEST OF THE SU(3) SYMMETRY IN THE HIGH ENERGY TWO-BODY REACTIONS. Fujimura, Kimio; Kobayashi, Tsunehiro; Ohba, Ichiro (Waseda Univ., Tokyo). Progr. Theor. Phys. (Kyoto), 39: 528-9(Feb. 1968).

A systematic investigation is made of the validity of SU(3) symmetry in high-energy two-body and quasi-two-body reactions by analyzing the experimental data. The dependence of the t-channel amplitude on the hypercharge and the isospin is examined, considering processes of the types $P_8B_8 \rightarrow P_8B_8$ and $P_8B_8 \rightarrow P_8B_{10}^*$. (L.B.S.)

29740 ON THE EQUAL MASS SPACING OF THE DECUPLET OF $J^P = 3/2^+$ BARYONS. Slansky, Richard Cyril. Berkeley, Calif., Univ. of California, 1967. 126p.

Thesis.

With the assumption that the unperturbed amplitude is known in the ND^{-1} representation, equations are derived for calculating the perturbed amplitude as a function of the variations of the left-hand singularities and the unitarity cuts. Exact formulas for mass and coupling-constant shifts of bound states of the unperturbed amplitude are given, and the equations are then iterated to yield a perturbation theory. The response of the decuplet masses to octet perturbations of the meson and baryon masses and couplings is studied in the ND^{-1} model of baryon-meson scattering, and it is found that the equal mass spacing of the decuplet is satisfied, even for large values of the symmetry breaking. The numerical inaccuracy of several forms of perturbation theory indicates that the physical baryon masses represent a large symmetry breaking in the calculation of the decuplet; so large that first- and second-order perturbation theories do not explain the equal mass spacing of the decuplet, although experiment and the exact solution to the model do give equal spacing. The rapid breakdown of the octet sum rules for the S-matrix elements also suggests that the SU(3) violations are large, and that the octet output is special to the masses. (Disser. Abstr.)

29741 A NEW LIE GROUP FOR THE SCALAR SU(3) SYMMETRIC STRONG COUPLING THEORY. Melsheimer, O. (Univ., Marburg, Ger.). Nucl Phys., B5: 479-91(1968).

A new Lie group $K = G_0(8) \otimes SU(3)$ is proposed which is more suitable for a group theoretical description of the scalar SU(3)-symmetric strong coupling theory of Dullemond than one previously considered. $G_0(8)$ is a 17-dimensional non-Abelian "translation" group. It is shown that there exists one single unitary irreducible representation of K which leads to a complete group-theoretical description of the theory in question. The physical relevance of all other unitary irreducible representations of K is discussed. (auth)

Field Theories

Refer also to abstract 29064.

General

29742 (NP-17377) CALCUL DES CORRECTIONS RADIATIVES JUSQU'AU 6eme ORDRE INCLUS. (Calculation of Radiative Corrections up to and Including the 6th Order). Calmet, Jacques (Aix-Marseilles Univ. (France). Faculte des Sciences). Dec. 19, 1966. 86p. (In French). Dep.

Thesis.

The calculation of the perturbations were made within the framework of the self-interaction scalar field of the $\lambda\varphi^3$ type. The study of the renormalization in functional formalism was made with all the results being given in momentum space. The graphic method used and the representation of the first six approximations of the finite part of the functional generator of the propagators are reported. The finite part of the contribution of the divergent graph of the second order is calculated, and the important properties are described. The contribution of the graphs pertaining to the 3rd, 4th, 5th, and 6th orders is calculated. The principle used is developed for the 4th order. The results obtained are tabulated. (J.S.R.)

Quantum Field Theory

Refer also to abstracts 29641, 29653, and 29730.

29743 (DESY-68/11) FORMULIERUNG EINER RELATIVISTISCHEN QUARK-FELDTHEORIE. (Formulation of a Relativistic Quark-Field Theory). Gudehus, Timm (Hamburg Univ. (West Germany). Institut fuer Theoretische Physik (II)). Feb. 1968. 66p. (In German). Dep.

Based on a set of appropriately modified Wightman axioms, a relativistic quark-field theory is formulated. The Haag-Ruelle construction of asymptotic states in the form given by Hepp is used to construct the asymptotic states of the phenomenologically known particles with the help of the basic quark fields. General reduction formulas for the reduction of the S-matrix elements to the expectation values of time ordered products of the quark field are given. Some useful concepts are introduced, such as phenomenological fields, general currents, and the Bethe-Salpeter amplitudes of some phenomenological particles. A decomposition into covariants as well as a spectral representation for the Bethe-Salpeter amplitudes of the mesons is derived from the axioms. For the expectation value of a general current between meson or baryon states, an expression due to Mandelstam is generalized. These expressions for the current expectation values contain the Bethe-Salpeter amplitudes of the phenomenological particles. A fundamental ansatz for the Bethe-Salpeter amplitudes of the pseudoscalar mesons, the vector mesons, the $1/2^+$-baryons, and the $3/2^+$-baryon resonances is made which implicitly contains the principles of the nonrelativistic quark model. This ansatz, together with the generalized Mandelstam formula, is the starting point for the calculation of current expectation values. Relations can be derived between the electromagnetic, weak and strong coupling constants and between form factors which differ from the known SU(3), SU(6), U(12) or nonrelativistic quark-model expressions by some mass factors. These mass factors may be important, for example, in the expression $g_{\rho\gamma}^2 : g_{\omega\gamma}^2 : g_{\phi\gamma}^2 = 9\ M_\rho : M_\omega : 2\ M_\phi$ for the vector meson-photon coupling constants $g_{V\gamma} = M_V^2/2\gamma_V$. Furthermore, the two new relations $g_{\omega\pi\gamma} = e/\sqrt{M_\omega M_\pi}$ and $g_{\rho\gamma} = 3/\sqrt{2}\ \sqrt{M_\rho M_\pi}/\cos\theta_A \cdot f_\pi$ are derived. The first gives an absolute value for the partial width $\Gamma_{\omega\rightarrow\pi+\gamma}$ of 1.22 MeV, which is in reasonable agreement with the experimental value 1.2 MeV. The second relation connects the ρ-γ coupling constant $g_{\rho\gamma}$ with the weak decay constant f_π of the pion and is fulfilled within 10%. (auth)

29744 (ITF-67-25) MODEL VZAIMODEISTVIYA S PROIZVODNYMI DOPUSKAYUSHCHAYA TOCHNOE RESHENIE. (Interaction With Derivatives Model Admitting an Exact Solution). Medvedev, B. V.; Polivanov, M. K. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1967. 29p. (In Russian). (CONF-670544-9). Dep.

From Conference on Axiomatic Quantum Field Theory and Elementary Particles, Kiev, USSR.

The quadratic-in-fields-interaction-with-derivatives model which is responsible for the renormalization of field operators is considered. Explicit expressions for the Heisenberg field and current operators are obtained. The formalism being repeated, the renormalization constants are replaced by integral operators of a special kind. In addition, the renormalization of the terms off and on the energy shell is different. The account of this allows one to overcome some difficulties when the condition of integrability for currents is renormalized in Bogolyubov's axiomatics. (auth)

29745 (ITF-67-30) DINAMICHESKII APPARAT AKSIOMATICHESKOGO METODA DLYA KVANTOVOI ELEKTRODINAMIKI. (Dynamical Apparatus of Axiomatic Approach in Quantum Electrodynamics). Pavlov, V. P.; Sukhanov, A. D. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1967. 30p. (In Russian). (CONF-670544-10). Dep.

From Conference on Axiomatic Quantum Field Theory and Elementary Particles, Kiev, USSR.

The dynamical equations of Bogoliubov's axiomatics are solved effectively for spinor electrodynamics by the method developed by Medvedev, Polivanov, Sukhanov. Heisenberg currents and current-like operators $\Lambda^{(n)}$ are obtained, in terms of which are expressed some products of Heisenberg operators including equal-time commutators of Heisenberg currents and fields. The proper commutator of the components of electromagnetic current is equal to zero while the commutator of spinor and electromagnetic currents involves a term of the Schwinger type. (auth)

29746 EQUIVALENCE OF TWO FORMULATIONS OF MASSIVE SPIN-ONE FIELD THEORY. Cukierda, T.; Lukierski, J. (Univ., Wroclaw). Nucl. Phys., B5: 508-14(1968).

It is shown that Weinberg's theory of spin-one particles, with the (1,0) + (0,1) representation as a primary one, is identical with the conventional Proca theory, based on the $(1/2,1/2)$ representation. The local Lagrangian for an antisymmetric massive tensor field of rank two, leading to the conventional theory of spin-one particles, is given. (auth)

29747 GAUGE FIELDS WITH NONINVARIANT INTERACTIONS. Fitzgerald, R.; Schiminovich, S. (City Univ. of New York, N. Y.). J. Math. Phys. (N. Y.), 9: 73-80(Jan. 1968).

Gauge fields interacting with source fields in a gauge-noninvariant way are examined in a purely classical framework. The

existence of conserved currents for the solutions of such theories follows from the properties of the free gauge fields rather than from the usual requirement of global gauge covariance. One of the simplest gauge-noninvariant theories of electromagnetism is shown to be an extension of Dirac's theory of classical clouds of charge. In this extension the clouds exhibit some quantum features. Gauge-noninvariant interactions for Einstein's theory of gravitation are presented in which the properties of the sources are carried by the metric field. In the case of the Yang–Mills field, internal symmetries for a real scalar source are a consequence of the properties of the gauge field. (auth)

29748 HOMOLOGICAL STUDY OF THE GENERALIZED SINGULAR FUNCTIONS. II. KAELLEN FUNCTIONS AND THEIR ANALYTICITY PROPERTIES. Minami, Masatsugu (Kyoto Univ.). Progr. Theor. Phys. (Kyoto), 39: 460-83(Feb. 1968).

The study deals exclusively with the Källén distributions introduced in I. They are redefined as the transposed images of an invariant integral by the mappings of the space of four-momenta q_l into a space of invariants (q_l, q_l). Next we newly define Källén functions as Borel transforms of the residue form rés $\Omega_{(n)}/(Q^{n-1}/\cup_l S_l)$, and then their analyticity properties are investigated on the basis of similar mapping consideration. (auth)

29749 GENERALIZED FIELD QUANTIZATION PROCEDURE. Hayes, C. F. (Univ. of Hawaii, Honolulu). Nuovo Cim., 54A: 991-4(Apr. 21, 1968).

It is shown that the generalized procedure proposed by Parks (Jour. Math. Phys., 7: 1049(1966)) for Bose fields may be consistently extended to give new meaning to N_K while retaining the usual number-operator convention. It is also noted that the correspondence of the creative and annihilation operators to the angular-momentum operators may be generalized to adequately include the irreducible spherical-tensor operator of arbitrary rank. (L.B.S.)

29750 PARTIALLY CONSERVED DILATATION CURRENT. Mack, G. (Univ., Bern). Nucl. Phys., B5: 499-507(1968).

Dilatations in space-time, $x_\mu \rightarrow \rho x_\mu$, are considered as a broken symmetry. The conjecture is advanced that the divergence of the corresponding current emphasizes low frequencies. Linked with current algebra and PCAC this provides a physical interpretation of the so-called σ terms arising in this framework. A corresponding general method to calculate these terms is outlined. Generally speaking, the σ terms turn out to be proportional to a rather small overall factor $\approx \mu_\pi / M_N$, but several mechanisms are pointed out by which they can nevertheless become important. (auth)

29751 POSITRONIUM SINGULARITIES IN QUANTUM ELECTRODYNAMICS AND PERTURBATION THEORY. Braun, M. A. (Leningrad State Univ.). Zh. Eksp. Teor. Fiz., 54: 1220-7(Apr. 1968). (In Russian).

Charge singularities in quantum electrodynamics due to positronium formation are investigated. Terms which such singularities in the proper electron mass and in vacuum polarization are expressed explicitly. It is shown that the dispersion relations in perturbation theory should be written down without taking into account poles corresponding to the compound particles. (auth)

29752 THE DESCRIPTION OF COMPOSITE PARTICLES BY MEANS OF CONDITIONS Z = 0. Braun, M. A. (Leningrad State Univ.). Nucl. Phys., B5: 392-402(1968).

It is shown that in a relativistic scalar field theory with a composite particle the introduction of an independent field for the composite particle eliminates the singularities in the coupling constant due to the composite particle and makes it possible to use perturbation theory. A non-linear bootstrap equation follows in a natural way for the form factor of the interaction with the composite particle. The parameters of the composite particle are determined by the equations $Z_1 = 0$ and $Z = 0$. The connection of this approach to the standard bootstrap is also studied. (auth)

29753 UNIFIED TREATMENT OF PHOTON AND NEUTRAL VECTOR MESON. THE FREE FIELD CASE. Burnel, A.; Caprasse, H. (Univ., Liege). Nucl. Phys., B5: 593-600(1968).

A quantized gauge invariant formulation of a neutral vector field Λ_μ is constructed. This field is unphysical but it is shown how the photon field equations in any covariant gauge as well as the neutral vector meson field equations can be derived from it. The related commutation relations are extracted from those of Λ_μ and the appearance of a Schwinger term in the usual equal time commutator for the vector meson is clearly displayed. (auth)

29754 DEVELOPMENT AND DISCUSSION OF PUGH'S QUANTUM ELECTRODYNAMICS. Glover, E. M. (Purdue Univ., Lafayette, Ind.). Ann. Phys. (N. Y), 46: 593-603(1968).

A mathematically more precise derivation of the Pugh equations for the S matrix is presented. These equations are applied to the calculation of the third-order vertex term. It is found that λ_v is finite. Also, a formal relationship is established between the Pugh vertex term and the renormalized Feynman vertex term. (auth)

Gravitation and General Relativity

Refer also to abstract 29747.

29755 A THEORY OF ANOMALOUS GRAVITATIONAL INTERACTION. III. BREAKDOWN OF THE BIANCHI IDENTITIES. Ezawa, Yasuo; Kimura, Toshiei (Hiroshima Univ.). Progr. Theor. Phys. (Kyoto), 39: 519-25(Feb. 1968).

The origin of anomalous gravitational interactions of the Dirac particle, whose gravitational form factors have an analogy with those of the anomalous magnetic moment and the electric dipole moment, is investigated. Following close parallelism to the electrodynamics, it is shown that the appearance of the anomalous gravitational interaction is attributed to the breakdown of the Bianchi identities in the ordinary theory of general relativity. The effect of the breakdown of the Bianchi identities is also touched briefly in connection with the framework of the generalized theory of quantum field including the gravitational field. (auth)

29756 CLASS OF GENERALIZED SINGULAR ELECTROMAGNETIC FIELDS. Zund, J. D. (North Carolina State Univ., Raleigh). Nuovo Cim., B, 55: 15-20(May 11, 1968).

The Bel–Lapiedra–Montserrat equations are solved in a conformally flat space-time to give a class of generalized singular electromagnetic fields. In the Minkowski space-time of special relativity it is shown that these solutions consist of three arbitrary holomorphic functions. (auth)

29757 GAUGE THEORIES OF MASSIVE AND MASSLESS TENSOR FIELDS. Hayashi, Kenji (Kyoto Univ.). Progr. Theor. Phys. (Kyoto), 39: 494-515(Feb. 1968).

Extension of the Poincaré group is performed by replacing its ten constant parameters by ten arbitrary functions. (For the purpose of comparison, similar procedures to extend a direct product of translation and internal symmetry groups are also carried out.) Two independent sets of gauge fields are introduced corresponding to the group structure of semi-direct product of the translation and Lorentz groups. It is an essentially new result that the gauge fields associated with the Lorentz group can be massive only when free Lagrangians for both sets of gauge fields are considered simultaneously. It is shown that there are two solutions to satisfy the requirement that there should be no mass terms in resultant equations. A choice adopted here is to impose field-field strength identity, viz., to represent the gauge fields of the Lorentz group in terms of the field strengths associated with the translation group; thus a set of equations is obtained to govern gravitation and further symmetrized energy-momentum tensors as its source. All arbitrary coefficients (except for a cosmological constant) in free Lagrangians are determined by means of linear approximation. With a reasonable identification between the gauge fields and the metric tensors, the ensuing equations are shown to be equivalent to Einstein's equation of gravitation. (auth)

29758 GRAVITATIONAL FIELD OF PLANES IN GENERAL RELATIVITY. Horsky, J. (Purkyne Univ. Brno). Czech. J. Phys., 18: 569-83(1968).

From the requirement of the plane symmetry the form of the exterior and static gravitational field of the plane shell is found. Its geometry is demonstrated by embedding the selected sections into the plane space. The exterior solution is linked up with the plane and with the couple of plane-parallel planes at rest. It is shown that the existence of strong pressures in the planes (which are necessary for the manifestation of the rest of both planes) makes it difficult to compare it directly with the corresponding classic case. If the pressure is relaxed, the planes will move towards one another by hyperbolic motion. It is shown that the hyperbolic acceleration of the plane is the same as in the classical case. The gravitational field outside the plane remains static so that no gravitational radiation arises. (auth)

29759 INFINITE CYLINDER WITH MULTIPOLE MOMENTS IN GENERAL RELATIVITY. Jackson, J. C. (King's Coll., London). Proc. Cambridge Phil. Soc., 64: 491-501(Apr. 1968).

The exterior metric of an infinitely long cylinder whose parameters vary periodically along its length is obtained as a Weyl type solution in terms of Bessel functions, and extended into the interior of the source. The question of inductive energy transfer between two co-axial cylinders of this nature is considered. (auth)

29760 LORENTZ-INVARIANT METHOD OF GRAVITATIONAL PERTURBATION. Carmeli, M. (Univ. of Maryland, College Park). Nuovo Cim., B, 55: 220-43(May 11, 1968).

A Lorentz-invariant method for obtaining equations of motion out of Einstein's gravitational field equations is developed. The method is based on the assumption that the metric tensor as well as every field function can be expanded into a power series in the gravitational constant k. The world-line of each particle is described parametrically as $x^{\mu}(\tau)$ where τ measures the Minkowskian distance along the path of the particle which is considered as a curve in the flat background metric. Each world-line is further characterized in a geometrical fashion by its three scalar curvatures and it is assumed that the first curvature is of the order of magnitude of the gravitational constant k. Equations of motion are derived explicitly in linear approximation, which can be considered as a Lorentz-invariant extension of Newton's law, and implicitly in the second approximation. The method is then applied to the simple problem of motion of a test particle moving in a field of a large particle, where the forces are determined up to second order in k. A detailed discussion is given in comparing the results with those obtained by other methods in connection with the problem of perihelion advance. It is shown that gravitational radiation effects found in other methods are not relevant in the linear approximation as was thought before. It seems that the equations of motion previously obtained are not consistent as to "order"; the use of the Frenet curvatures in the method does give a systematic order for the equations obtained. No attempt was made to extend the method to describe hydrodynamical motion. (auth)

29761 ON THE TRANSFORMATIONS OF COORDINATES ELIMINATING SINGULARITIES ON THE GRAVITATIONAL RADIUS IN SCHWARZSCHILD METRIC. Fomin, P. I. (Physical-Technical Inst. of Low Temperatures, Kharkov). Zh. Eksp. Teor. Fiz., 54: 905-9(Mar. 1968). (In Russian).

It is shown that the transformations eliminating singularities in the Schwarzschild metric possess, if represented in the form of local Lorentz transformations, the following general characteristics: the parameter of transformation V having the meaning of the local velocity of the new system of coordinates with respect to the initial system reaches the velocity of light on the Schwarzschild sphere. A general recipe is formulated for constructing the coordinates in which the Schwarzschild metric has no singularities on the gravitational radius. (auth)

29762 REMOVABLE SINGULARITIES AND THE PRINCIPLE OF CAUSALITY IN GENERAL RELATIVITY. Gliner, E. B. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Eksp. Teor. Fiz., 54: 796-807(Mar. 1968). (In Russian).

Conditions are established under which the space-time structure is compatible with the possibility of the joint conformity to the principles of causality and equivalence ("causal completeness"). From the point of view of the fulfilment of these conditions a study is made of metric forms with removable singularities similar to that on the gravitational radius in Schwarzschild's metric form. The solution of the Einstein's equations represented by such forms have to be expanded for the conformity to the established conditions, but the expansion thus required is much more narrow than already obtained by the Kruscal's method. A connection is established between the two types of expansions. (auth)

29763 SIGN OF GRAVITATIONAL ENERGY. Brill, D. (Yale Univ., New Haven); Deser, S.; Faddeev, L. Phys. Lett., 26A: 538-9(Apr. 22, 1968).

The general variational property of the total energy of a general relativistic system, that it is extremized by the vacuum state (flat space), is established in a simple fashion from the Hamiltonian nature of the theory. Its relation to the positiveness problem is discussed. (auth)

29764 STRUCTURE OF THE CURZON METRIC. Stachel, J. (Boston Univ.). Phys. Lett., 27A: 60-1(May 20, 1968).

It is shown that the Curzon metric for positive mass contains a singular event horizon of infinite area: and that consequently the three-dimensional spatial hypersurfaces orthogonal to the Killing vector field are multiply connected. (auth)

29765 SYMMETRIC-TENSOR–ANTISYMMETRIC-TENSOR THEORY OF GRAVITATION AND ELECTROMAGNETISM FROM A QUATERNION REPRESENTATION OF GENERAL RELATIVITY. Sachs, M. (State Univ. of New York, Buffalo). Nuovo Cim., B, 55: 199-219(May 11, 1968).

The factorization of Einstein's formalism into a pair of simultaneous quaternion field equations in general relativity entails the enlargement of the original formalism from 10 to 16 independent relations. By iteration, the quaternion field equations are shown to be physically equivalent to a symmetric-tensor–antisymmetric-tensor formalism. The symmetric-tensor part is in one-to-one correspondence with the 10 relations of Einstein's original theory of gravitation. The remaining 6 (antisymmetric tensor) relations have no counterpart in the earlier gravitational theory. In addition to the generalization of the metrical field (and therefore the description of gravitational forces) that follows from the incorporation of the antisymmetric-tensor contribution, the covariant divergence of the latter formalism automatically leads to a system of field equations whose structure is in one-to-one correspondence with the Maxwell theory for electromagnetism. It is shown that Einstein's original formalism entails 10, rather than 16 relations, because, in addition to its covariance under the group of general relativity (a connected topological group) it is also covariant under time and space reflection transformations. The latter is an undue restriction since it is not required by the principle of general relativity alone. When these discrete symmetry elements are dropped, the (more general) quaternion formalism results. With the expression of the latter (which is not sensitive to the "handedness" of space or the direction of time) as the sum of two formalisms —one that is even and the other odd under space or time reflections —the original 10 relations of Einstein's equations plus the 6 relations that lead to the Maxwell field equations follow. Finally, with the application of the Schwarzschild conditions in the anti-symmetric-tensor part of the field equations, they reduce (in order v/c) to a scalar-field formalism. With this approximation then, the full exploitation of the principle of general relativity —in terms of a symmetric-tensor–antisymmetric-tensor formalism— reduces to a scalar-tensor formalism, such as the one that has been studied by Brans and Dicke. It follows that to within the approximations that were considered in this comparison (which would be applicable to a derivation of planetary motion) the present theory and a truly scalar-tensor theory would be experimentally indistinguishable. In the derivation presented, however, the generalization of the metrical field to incorporate with the usual formalism an antisymmetric-tensor part (and therefore a scalar part in the application to planetary problems) follows in a natural way from the lowest-dimensional irreducible representations of the group of general relativity and no new fundamental constants need be introduced. (auth)

29766 A CRITICISM OF KASNER'S PROOF THAT NO SOLUTION OF $G_{\mu\nu} = 0$ CAN BE EMBEDDED IN A FLAT FIVE-SPACE. Jex, C. F. (Univ. of Lancaster, Eng.). Nuovo Cim., B, 55: 76-82 (May 11, 1968).

It is shown that Kasner's original proof that no solution of $G_{\mu\nu} = 0$ can be embedded in on E_5 rests on too restrictive assumptions, and that in fact these assumptions lead to contradictory results in the case of the Schwarzschild interior solution. (auth)

Scattering Theory

Refer also to abstracts 29650 and 29718.

29767 ASYMPTOTIC PROJECTIONS OF SCATTERING MODELS. Barger, V.; Olsson, M.; Reeder, D. D. (Univ. of Wisconson, Madison). Nucl. Phys., B5: 411-30(1968).

In an effort to delineate predictions of current phenomenological scattering models that can be tested on higher-energy accelerators, models for total cross sections, ratio of real to imaginary amplitudes at t−0, and elastic scattering differential cross sections were extrapolated to the 50−1000 GeV/c momentum range. It is found that the asymptotic limit is essentially reached by 200 GeV/c in Regge-pole models that have a Pomeranchuk trajectory. The predictions of a model with zero total cross sections at infinity are contrasted with a model having constant asymptotic total cross sections. Extrapolations of a conventional diffraction model are briefly considered. (auth)

29768 EFFECT OF CHANNEL COUPLING ON THE REAL PHASE SHIFT. Furuichi, Susumu; Suzuki, Haruo (Rikkyo Univ., Tokyo). Progr. Theor. Phys. (Kyoto), 39: 420-9(Feb. 1968).

To make clear the relation between the real phase shift of the elastic scattering and the absorption phenomena, the effect of channel coupling on the real phase shift is investigated by using a pole approximation to the multichannel ND^{-1} method. It is shown that the channel coupling increases the real phase near the threshold energy and decreases it at energy sufficiently high above the threshold of the inelastic channel. (auth)

29769 IMPACT PARAMETER REPRESENTATION OF THE SCATTERING PROBLEM. Adachi, Toshimi (Tokyo Metropolitan Technical Coll.); Kotani, Tsuneyuki. Progr. Theor. Phys. (Kyoto), 39: 430-52(Feb. 1968).

The new exact treatment of the scattering problem proposed by Adachi and Kotani is summarized in a more complete form. This impact parameter representation and the partial wave expansion are complementary. The former is more suitable in the short

wavelength region, while the latter in the long wavelength region. By assuming a short wavelength approximation only, many formulae are simplified in the former expansion; in the case of the potential scattering, the simple relation between the scattering amplitude and the (optical) potential is obtained by applying this approximation to the correct solution in the complete form of the Born series. This result is identical with the form obtained under the eikonal or semiclassical approximation. It is proved that the total cross section in the high energy region is expressed accurately in this approximate form, but the angular distribution is less accurate for some cases. As examples, the scattering by a square well potential and the charge exchange scattering of protons by hydrogen atoms are discussed. The relations with the other impact parameter formalisms proposed by Blankenbecler and Goldberger and others are discussed. The solution obtained by Blankenbecler and Goldberger for potential scattering is shown to be the simplest solution which satisfies the unitarity relation under the short wavelength approximation. The reason why their solution is different from the eikonal form is explored by deriving the exact dispersion relation. The Schrödinger equation in the impact parameter representation is derived. (auth)

29770 KINEMATICAL SINGULARITIES, CROSSING MATRIX, AND KINEMATICAL CONSTRAINTS FOR TWO-BODY HELICITY AMPLITUDES. Cohen-Tannoudji, G.; Morel, A.; Navelet, H. (CEN, Saclay, Gif-sur-Yvette, France). Ann. Phys. (N. Y.), 46: 239-316(Feb. 1968).

Helicity amplitudes are expressed via the spinor amplitudes in terms of the Joos invariant amplitudes which have been shown by Williams to be free from kinematical singularities. This procedure allows the kinematical singularities of helicity amplitudes to be analyzed and separated out, which results in the definition of regularized helicity amplitudes. A crossing matrix for helicity amplitudes, is written down, corresponding to the continuation path used to cross spinor amplitudes. It is verified explicitly that the corresponding crossing matrix for regularized helicity amplitudes is uniform, as it should be. Kinematical constraints which generalize, to the case of arbitrary spins and masses, relations which must hold between helicity amplitudes at some values of the energy variable in $\pi N \to \pi N$, $\pi\pi \to N\bar{N}$, and $N\bar{N} \to N\bar{N}$ reactions, appear as a consequence of the existence of poles in the crossing matrix between regularized helicity amplitudes. (auth)

29771 MIXING OF REGGE POLES AND CUTS IN PERTURBATION THEORY. Zakrzewski, W. J. (Univ. of Cambridge, Eng.). Nucl. Phys., B5: 403-10(1968).

The mixing of the Regge poles generated by ladder diagrams in a $\lambda\varphi^3$ theory with the moving cut generated by non-planar graphs containing an internal ladder and a particle of spin one is discussed. The expected mixing is confirmed in this case. (auth)

29772 ON THE NECESSITY OF PRODUCTION AMPLITUDES IN S-MATRIX THEORY. I. Cheung, Franklin F. K. (State Univ. of New York, Stony Brook). Ann. Phys. (N. Y.), 46: 203-19(Feb. 1968).

It is shown that production amplitudes are necessary in two-particle scattering with any isotopic spins. The proof assumes that the amplitudes satisfy the analyticity requirements of Mandelstam representation with a finite number of subtractions and the result is based on the interconnection between unitarity condition and crossing relation. (auth)

29773 ON THE NECESSITY OF PRODUCTION AMPLITUDES IN S-MATRIX THEORY. II. Cheung, Franklin F. K. (State Univ. of New York, Stony Brook). Ann. Phys. (N. Y.), 46: 220-38(Feb. 1968).

It is shown that as a consequence of consistency between unitarity and crossing relations, production amplitudes are necessary in two-particle scattering with any spins and isotopic spins. The proof assumes that the scattering amplitudes satisfy the analytical requirements of the Mandelstam representation with a finite number of subtractions. (auth)

29774 ON THE NORMALIZATION OF THE BETHE–SALPETER WAVE FUNCTION IN THE UNEQUAL-MASS CASE BY MEANS OF THE STEREOGRAPHIC PROJECTION METHOD. Seto, Kenji (Hokkaido Univ., Sapporo). Progr. Theor. Phys. (Kyoto), 39: 453-9(Feb. 1968).

The stereographic projection method, which was introduced by Cutkosky in solving the Bethe–Salpeter equation in the equal-mass case, is applied to solving the B-S equation in the case where the constituent particles have different masses. The solution thus obtained is expressed in a spectral representation, which enables us to calculate the norm of the B-S amplitude for arbitrary $n-l-1$ where n and l are the principal and the angular momentum quantum numbers. The solution coincides with that obtained by Nakanishi for $n-l-i = 0.1$ and 2. (auth)

29775 ONE-PARTICLE-EXCHANGE MODEL FOR LOW-ENERGY SCATTERING. I. THE ONE-CHANNEL PROBLEM. Banyai, L.; Rittenberg, V. (Inst. of Physics, Bucharest). Ann. Phys. (N. Y), 46: 435-52(Feb. 1968).

A crossing symmetrical, one-particle exchange type simple spectral representation is proposed for the low-energy scattering of spinless mesons. This representation together with the partial-wave unitarity allows for methods of computing the low-energy scattering amplitude. The iterational methods, which use the reaction matrix formalism, permit one to obtain for low energy either crossing symmetrical analytical amplitudes, satisfying approximately the unitarity or unitary, analytic amplitudes which verify approximately the crossing symmetry. A special attention is given to the case of narrow resonances, when several useful approximations are proposed. Selfconsistency, bootstrap-type conditions are derived for the determination of the masses and coupling constants of stable and unstable particles and antibound states, by imposing unitarity to our crossing symmetrical amplitude near the corresponding singularity. (auth)

29776 ONE-PARTICLE-EXCHANGE MODEL FOR LOW-ENERGY SCATTERING. II. THE MANY-CHANNEL PROBLEM. Banyai, L.; Rittenberg, V. (Inst. of Physics, Bucharest). Ann. Phys. (N. Y.), 46: 494-508(Feb. 1968).

The procedure previously developed to determine low energy scattering amplitudes in the one-channel case, is extended to the many-channel case. Methods of successive approximations may be again formulated. Bootstrap equations are derived from self-consistency requirements, which may be interpreted as either imposing approximate unitary to crossing symmetrical amplitudes or imposing approximate crossing symmetry to unitary amplitudes. As a byproduct some general properties of the scattering amplitudes in the many-channel scattering problem are obtained. (auth)

29777 THREE-PARTICLE K-MATRIX. Graves-Morris, P. R. (Cambridge Univ., Eng.). Nuovo Cim., 54A: 817-34 (Apr. 21, 1968).

The scattering amplitude for three identical but distinguishable completely scalar particles is analyzed using on-mass-shell methods. It is shown that cuts due to coupled two-body channels may be removed by a K-matrix method, leaving the uncoupled purely three-body problem to be solved. An integral equation is presented for the three-particle amplitude in terms of a reduced amplitude with no three-body cut, which is the three-particle K-matrix. The sub-energy normal thresholds and cross energy poles of this are easily exposed and removed. The feasibility of boundary value interchange is discussed in terms of a new, unitary model. (auth)

29778 VALUES OF THE POTENTIAL AND ITS DERIVATIVES AT THE ORIGIN IN TERMS OF THE S-WAVE PHASE SHIFT AND BOUND-STATE PARAMETERS. Calogero, F. (Univ., Rome. Istituto Nazionale di Fisica Nucleare, Rome); Degasperis, A. J. Math. Phys. (N. Y.), 9: 90-116(Jan. 1968).

The framework of this discussion is the quantum-mechanical theory of nonrelativistic scattering of a particle by a spherically symmetrical, local, and energy-independent potential. The principal results are explicit expressions for the values at the origin of the potential and of its derivatives in terms of the S-wave scattering phase shift and of the parameters of the S-wave bound states (if any). Previous work in this direction is reviewed, and different routes to the establishing of these results are discussed. Some remarks concerning the characterization of S-wave physically equivalent potentials (i.e., potentials having the same S-wave phase shift and S-wave binding energies) are presented. The properties of the S-wave phase shift and bound state parameters which are necessary and sufficient to ensure that the corresponding potential be an even function of r are ascertained. The analysis is restricted to potentials represented by holomorphic functions of r. (auth)

29779 A SIMPLE DERIVATION OF THE EXACT PSEUDOPOTENTIAL FOR N HARD SPHERES. Miglietta, F. (Univ., Pavia, Italy). Nuovo Cim., B, 55: 280-2(May 11, 1968).

A straightforward derivation is given for the exact pseudopotential for N hard spheres. This derivation is different from those previously given. (J.F.P.)

Particle Accelerators

Refer also to abstracts 28168, 28226, 29461, 29462, 29536, 29805, 29807, 30048, and 30365.

29780 (BNL–12434) ELECTRIC FIELD ON LINAC DRIFT TUBE SURFACES. Jellett, K.; Parzen, G. (Brookhaven National Lab., Upton, N. Y.). Apr. 16, 1968. 4p. Dep. CFSTI.

The electric field distributions on linac drift tube surfaces, calculated with the JESSY computer program, are presented graphically. Data given are for cells in the BNL 200-MeV linac. (W.H.K.)

29781 (CERN-68-6) ACCEPTANCE ANGULAIRE DU QUADRUPLET DE RETOURNEMENT. (Angular Acceptance of the Turn-over Quadruplet). Regenstreif, E. (European Organization for Nuclear Research, Geneva (Switzerland)). Feb. 27, 1968. 97p. (In French). Dep.

The angular acceptance of a turn-over quadruplet is studied as a function of its physical parameters: magnetic gradient of the lenses, length of the magnetic elements, length of the slip spaces, etc. A simple formula is derived for the calculation of the angular acceptance. The properties of the turn-over quadruplet are reviewed and the partial acceptances of such a quadruplet are calculated. The existence of a separator, defining two different zones of operation, one region where the acceptance has a continuous form as a function of the source position and another region where there are retrogression points, is shown. In the first case the acceptances are limited by the interior lens, whereas in the second the limitation is attributed either to the interior lens or the exterior lens, according to the source position. The highest acceptances are attained in the operating region where there are retrogression points. The total acceptance does not have a maximum, but has a minimum when the operation is symmetrical. The acceptance in the symmetrical regime can be made maximum when the focussing possibilities are carried to the extreme. Numerical calculations are made of this effect, and curves are given that permit the form of the acceptance to be followed as a function of the focussing parameters and of the total distance imposed. The manner in which it is suitable to act on the aperture radii of the lens in order to exploit to the maximum its transmission capacities is indicated. (tr-auth)

29782 (CERN-68-8) THE CERN ELECTRON STORAGE AND ACCUMULATION RING (CESAR). (European Organization for Nuclear Research, Geneva (Switzerland)). Mar. 6, 1968. 187p. Dep.

A general description of CESAR is given, and a technical description of the Van de Graaff injector, the injection system, magnets and lenses, vacuum system, rf and operational control systems, the betatron core, and beam observation devices used with CESAR is presented. The results of experiments done with CESAR are reported including stacking efficiency, effects of rf noise, stacking with missing buckets, stacking with phase-lock, stack shaping by phase-displacement, energy spread at injection, beam lifetime, non-linear resonances, coherent transverse instabilities, and beam splitting on a non-linear resonance. Also, an attempt is made to evaluate the overall CESAR program. (W.H.K.)

29783 (CERN-68-11) NUMERICAL CALCULATIONS OF LINEAR ACCELERATOR CAVITIES. Martini, M.; Warner, D. J. (European Organization for Nuclear Research, Geneva (Switzerland)). Mar. 22, 1968. 65p. Dep.

A numerical method for computing the electromagnetic field and main design parameters of a linear accelerator cavity is presented. The solution of the finite difference form of the Helmholtz equation for a rotationally symmetric structure is obtained by a compound of an analytical and a point successive over-relaxation method. The relaxation technique, which is rather time consuming, has thus been confined to a relatively small axial region of the cavity and the overall computation time is considerably reduced. An effort has been made to collect together the basic theory, which is usually dispersed among many papers and on which these calculations are founded. A program for the CDC 6600 and 3800 computers, which can treat any regular drift-tube profile, is briefly outlined. The results of the application of this method to a 3-MeV experimental linac are given. (auth)

29784 (GEPP-28) SPACE-CHARGE SPREADING OF AN ION BEAM IN A UNIFORM ACCELERATING FIELD. Terhune, J. H. (General Electric Co., St. Petersburg, Fla. Neutron Devices Dept.). Apr. 22, 1968. Contract AT(29-2)-656. 27p. (R-68-ND-5). Dep. CFSTI.

A simplified model is developed to describe the space-charge spreading of an ion beam in a uniform accelerating gap. The model is a one-dimensional, steady-state, constant-current approximation to rigorous equations for ionic motion under the influence of space-charge and externally applied fields. Numerical results that describe the variation of ion beam radius with several parameters of the ion-optics system are presented. The analytical expressions deduced in this report are valid over limited ranges of the parameters, and are useful in engineering design of ion-optics systems. (auth)

29785 (NP-17359) EL ACELERADOR DINAMITRON Y ALGUNOS ASPECTOS DE SU SISTEMA ASOCIADO. (The Dynamitron Accelerator and Several Aspects of its Associated System). De la Cruz Reyna, Servando (Universidad Nacional Autonoma de Mexico, Mexico City. Facultad de Ciencias). 1967. 69p. (In Spanish). Dep.

Thesis.

The characteristics of the Dynamitron accelerator and its associated optical system are summarized. The oscillator, high voltage system, ion source, and accelerator tube of the Dynamitron are described. The vacuum system and ion optics are discussed. The characteristics of the associated spectrograph are also given. (J.S.R.)

29786 (UCRL-17932) BEVATRON OPERATION AND DEVELOPMENT. 55. JULY-SEPTEMBER 1967. Crebbin, Kenneth C.; Frias, Robert (California Univ., Berkeley. Lawrence Radiation Lab.). Jan. 31, 1968. Contract W-7405-eng-48. 14p. Dep. CFSTI.

The beam was off 5.8% of the scheduled operating time because of equipment failure and 5.8% of the time for experimental setup, tuning, and routine checks. The beam was on for 88.4% of the scheduled operating time. During this quarter, the Bevatron accelerated 2.05×10^{18} protons. The maximum operating beam intensity was raised to 4×10^{12} protons per pulse. Construction on the new External Proton Beam Hall and new two-channel beam facility continued. An experiment was set up at the second focus in channel I, and preliminary tests were made on the new beam transport system to that area. Tests continued on the resonant extraction system for the external proton beam. A generator field pole connection on one of the main motor generator sets failed on September 24. The Bevatron was shut down for about 2 weeks to rebraze all the field pole connections on both motor generator sets. (auth)

29787 (UCRL-18117) RADIATION SHIELDING FOR HIGH-ENERGY MUONS: THE CASE OF A CYLINDRICALLY SYMMETRICAL SHIELD AND NO MAGNETIC FIELDS. Keefe, D.; Noble, C. M. (California Univ., Berkeley. Lawrence Radiation Lab.). Mar. 1968. Contract W-7405-eng-48. 55p. Dep. CFSTI.

At proton accelerators with energies of tens of GeV and more, the shielding problems are dominated by the requirement of reducing the flux of muons to tolerable levels. This is especially true for accelerators making extensive use of extracted proton beams. A technique for calculating the profile of the radiation shield for muons for a number of practical situations of interest, viz., beam loss in an internal target area, beam loss during transport of the extracted proton beam down a long narrow pipe, and the case in which the extracted proton beam is dumped in a backstop is presented. Results obtained from a computer program are presented graphically for different possible shield materials—heavy concrete, iron, lead, and depleted uranium. The results span four orders of magnitude in muon flux normalized to the rate of interacting protons, so that one can obtain useful results by interpolation for a wide variety of beam loss and desired shielding situations. The primary proton energies used in the calculations—25, 70, 200, and 300 GeV—will be recognized as corresponding to the energies of proton accelerators at present either operating or under design. (auth)

29788 (UCRL-18125) PROPOSED SAWTOOTH BUNCHER FOR THE 88-INCH CYCLOTRON AXIAL INJECTION SYSTEM. Resmini, F.; Clark, D. J. (California Univ., Berkeley. Lawrence Radiation Lab.). Mar. 1968. Contract W-7405-eng-48. 23p. Dep. CFSTI.

A sawtooth wave buncher to be used in the axial injection system at the 88-inch cyclotron is described. Buncher mathematics, matching the cyclotron requirements, typical buncher parameters, and a survey of effects limiting the buncher operation are discussed. (W.H.K.)

29789 AN IMPROVED SOURCE OF POLARIZED NEGATIVE HYDROGEN IONS USING A POTASSIUM VAPOR CHARGE-EXCHANGER. Grueebler, W.; Koenig, V.; Marmier, P. (Eidgenossische Technische Hochschule, Zurich). Nucl. Instrum. Methods, 62: 115-16(June 1, 1968).

An improved source of polarized negative hydrogen ions is described. The intensity is increased through charge-exchange in potassium vapor while depolarization effects are suppressed with a strong magnetic field. (auth)

29790 ANALYSIS OF GENERAL MODE PROPAGATION AND THE PULSE-SHORTENING PHENOMENON IN ELECTRON LINEAR ACCELERATORS. Davies, J. B.; Goldsmith, B. J. (Mullard Research Labs., Redhill, Eng.). Philips Res. Rep., 23: 207-32(Apr. 1968).

Computed and experimental dispersion characteristics are

presented for modes of arbitrary angular dependence in circular iris-loaded waveguides. As well as the circularly symmetric modes, especially the "accelerating" E_{01} mode, angular-dependent modes are studied because of their role in the phenomenon of pulse shortening in electron linear accelerators. Computations are based on a close approximation of the field in the waveguide structure, and give Brillouin diagrams to the greatest usable accuracy in about about one minute computing time. Together with existing theory on the growth of the associated backward-wave oscillations, these computations assist greatly in the design of a waveguide structure for linear accelerators, and help in avoiding the problem of pulse shortening. Some novel and interesting results are presented for E_{01}, E_{02} and H_{01} modes, and for a variety of the angular-dependent modes. (auth)

29791 COMPUTER PROGRAM FOR THE CALCULATION OF TANDEM ACCELERATOR BEAM TUBE OPTICS. Cramer, J. G. (Univ. of Washington, Seattle). Contract AT(45-1)-1388. Nucl. Instrum. Methods, 62: 205-7(June 15, 1968). (RLO-1388-49).

A FORTRAN II computer program for the calculation of particle trajectories through inclined-field or straight accelerating tubes of the type commonly used in tandem Van de Graaff accelerators is described. Details of the program and results of tube optics calculations are discussed. (auth)

29792 CURRENT DISTRIBUTION FOR PRODUCING A MAGNETIC FIELD CONFIGURATION WITH GIVEN SYMMETRY IN A TWO-DIMENSIONAL PROBLEM. APPLICATION TO QUADRUPOLAR LENS. Mouza, J.-C. (CNRS, Orsay, France). Rev. Phys. Appl., Suppl. J. Phys., 3: 83-92(May 1968). (In French).

A current distribution is sought for producing a quadrupolar field configuration with constant gradient in an iron-free lens with circular aperture. This problem is studied for the two-dimensional case by assuming the conductors to be infinitely long. A calculation method is expounded in the complex representation, the exploitation of which allows one to examine recent achievements and projects and to give a general formation of the calculation of space harmonics. (auth)

29793 DESTRUCTIVE HYDROGEN TARGET TESTS AT THE PRINCETON-PENNSYLVANIA ACCELERATOR. Jankowicz, R. (Princeton Univ., N. J.). Rev. Sci. Instrum., 39: 848-53(June 1968).

The PPA standard hydrogen target system was tested for a catastrophic failure of the target flask. Two tests were performed. In the second test, the size of the vacuum housing surrounding the target flask was reduced. The resulting pressures, effect on the Mylar windows, and a single phase analysis of the gas flow are discussed. (auth)

29794 DETERMINATION OF THE POLE PROFILE FOR BETATRONS. Geske, G.; Hergt, R. (Friedrich-Schiller-Univ., Jena, Ger.). Exp. Tech. Phys., 15: 80-8(1967). (In German).

A semi-empirical method for the calculation of pole profiles for betatrons was discussed. A numerical method for the solution of the Laplace equation was used for the calculation of the field index by means of a computer. The computer program for the ZRA-1 was described. The results of the calculations were discussed and experimentally checked. (tr-auth)

29795 DIFFUSION OF RARE EARTHS OUT OF VARIOUS METALS IN THE Ta TO Au REGION. Andersen, Marie-Louise; Scharff, Bente (Univ. of Copenhagen). Ark. Fys., 36: 151-3 (1967).

From International Symposium on Why and How Should We Investigate Nuclides Far Off the Stability Line, Lysekil, Sweden. See CONF-660817.

It is shown that some of the rare earths can be diffused out of tungsten, rhenium, platinum, and gold. In all cases, pieces of foil with thickness of 0.1 and 0.2 mm were used, which had been bombarded with 600-MeV protons in the CERN synchrocyclotron. (B.G.D.)

29796 EXISTING AND CONTEMPLATED LOW AND MEDIUM ENERGY ACCELERATORS FOR THE FUTURE. Ramler, Warren (Argonne National Lab., Ill.). Ark. Fys., 36: 19-39(1967).

From International Symposium on Why and How Should We Investigate Nuclides Far Off the Stability Line, Lysekil, Sweden. See CONF-660817.

Existing and future sources of light and heavy ions, photons and neutrons are discussed. Contemplated accelerators such as the HIVEC (ANL), Omnitron (LRL), SOC (Chalk River and ORNL), King Tut (ORNL), and the Los Alamos Linac will be considered along with the new era of high current electron linear accelerators. Recent developments have also established the capability of the Van de Graaff type accelerator to produce pulsed electron beams of many amperes. (auth)

29797 EXPERIMENTAL INVESTIGATION OF VARIATION OF ELECTRON BEAM CROSS DIMENSIONS IN THE 1.5 GeV SYNCHROTRON. Belik, Yu. A.; Vorob'ev, A. A.; Didenko, A. N.; Kozhevnikov, A. V. At. Energ. (USSR), 24: 25-8(Jan. 1968). (In Russian).

The effect of the quantum fluctuations of the synchrotron radiation on the transverse dimensions of the electron beam was investigated. The measurements were made at the energy of 1.2 GeV. It was shown that the effect of the quantum fluctuations of the radiation on the vertical betatron oscillations is insignificant. The radial oscillations of the electrons undergo significant oscillations, beginning at 630 MeV, which indicates the quantum character of the synchrotron radiation. At the end of the cycle of acceleration, stabilization of the radial oscillations was observed. The results obtained give satisfactory agreement with theory. (tr-auth)

29798 EXTERNAL PROBLEM FOR PARAXIAL ELECTRON BEAMS. Ovcharov, V. T. Radiotekh. Elektron., 12: 2156-61 (Dec. 1967). (In Russian).

An approximate analytical solution was obtained for electrode shape necessary for producing paraxial laminar electron beam. The solution obtained is considered to be the extension of the potential beyond the beam boundary taking into account the discontinuity of the second derivative. (tr-auth)

29799 FABRICATION OF ULTRATHIN FILMS. Vouros, Paul; Masters, Joseph I.; Starbie, Richard J. (Technical Operations, Inc., Burlington, Mass.). Rev. Sci. Instrum., 39: 741-3 (May 1968).

A method is described for the preparation of thin supported films of aluminum and carbon that can be several centimeters in diameter and contain as little as 1 $\mu g/cm^2$ of material. The thickness of the prepared films is estimated to be well below 100 Å with a total pinhole area of less than 0.01%. Aluminum and carbon films prepared by this method were found capable of supporting pressure differentials of 10^{-3} to 10^{-2} mm Hg across their areas, at a maximum pressure of 10^{-1} mm Hg on one side. (auth)

29800 FROM PLANNING TO REALITY THE DESIGN GOALS AND ACTUAL OPERATION OF A COMPACT, ISOCHRONOUS CYCLOTRON. Fleischer, A. A.; Hendry, C. O.; Smith, C. G.; Tom, J. L.; Wells, D. K. (Cyclotron Corp., Berkeley, Calif.). pp 435-51 of Proceedings of the 2nd Conference on Practical Aspects of Activation Analysis with Charged Particles, Liege (Belgium), September 21-22, 1967. Ebert, H. G. (ed.). Brussels, European Atomic Energy Community (EURATOM), 1968.

See EUR-3896; CONF-670947.

A compact AVF cyclotron was designed, manufactured, and completely tested in less than 18 months. This cyclotron was designed to meet the need for an inexpensive, reliable and easy-to-operate accelerator for activation analysis, isotope production, and low energy nuclear physics research. It accelerated very stable beams of protons to 15 MeV, deuterons to 8 MeV, He^{3++} to 20 MeV, and alpha particles to 16 MeV. External beam currents in excess of 50 μA, with very good energy resolution and small beam divergence, were obtained with all particles. The proper magnetic field for acceleration of all four particles is attained by using a three-sector magnet pole configuration and requires no profile coils. It uses two 120-degree dees to provide an energy gain of 100 keV per turn. The ion source, using ion-heated cathodes instead of the usual hot-filament, produces sufficient quantities of positive ions to obtain internal beams of more than one mA of protons and deuterons at extraction radius. It also has been used to produce 30 μA of H^- and D^- particles at full energy. (auth)

29801 GENERATION OF PHASE PLANE ELLIPSES BY ANALOG TECHNIQUES. Blackstein, F. P. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Rev. Sci. Instrum., 39: 768-9 (May 1968).

In design and analysis of charged particle transport systems it is convenient to represent the beam by its phase plane contours in the transverse planes. These contours are generally approximated by ellipses. An analog technique for plotting phase plane ellipses independently of digital tracking is outlined. (W.H.K.)

29802 HEAT TRANSFER THROUGH A THIN ROTATING NUCLEAR TARGET. Concus, P. (Univ. of California, Berkeley). Nucl. Instrum. Methods, 62: 199-202(June 15, 1968). (UCRL-17924).

The approximate time-dependent steady-state temperature of a thin rotating nuclear target system is found by solving the differential equation for a corresponding one-space-dimensional heat transfer problem in terms of an eigenfunction series. The series obtained can be evaluated numerically to necessary design accuracy with use of only a small amount of computer time. The results are given for a typical problem, for which the solution is depicted graphically. (auth)

29803 ISOLDE TARGET DEVELOPMENT AT CERN. Hageboe, E.; Kjelberg, A.; Sundell, S. (CERN, Geneva). Ark. Fys., 36: 127-32(1967).

From International Symposium on Why and How Should We Investigate Nuclides Far Off the Stability Line, Lysekil, Sweden. See CONF-660817.

A versatile target system for use with the isotope separator on-line (ISOLDE) with the extracted 600-MeV proton beam at the CERN synchrocyclotron has been designed and is at present being built. Some problems encountered in developing a target of this kind will be discussed. These are of basic physical and chemical origin as well as imposed by safety requirements. A series of feasibility tests has been performed with the main emphasis on: (A) Alkaline earth metal stearate targets for production and continuous extraction of noble gases. This system will be used in the initial phase of the running of ISOLDE. (B) A target container and heater capable of keeping any target material, solid or liquid at a temperature up to 1500°C during the irradiation. (auth)

29804 MEAN MULTIPLE SCATTERING CORRECTION TO THE ENERGY LOSS OF HEAVY PARTICLES. Tschalaer, C.; Bichsel, H. (Rutherford High Energy Lab., Chilton, Eng.). Nucl. Instrum. Methods, 62: 208-16(June 15, 1968).

The mean increase in energy loss $\overline{\delta T_m}$ due to multiple scattering of heavy particles is treated for thick absorbers. Using Molière's theory with the improvements by Nigal et al., the mean square and mean fourth power of the reduced scattering angle are calculated for all absorber materials, for incident energies larger than a few MeV, for energy losses up to 80% of the incident energy, and for circular detectors with angles of acceptance up to ±35°. A method is given for computing the mean energy correction $\overline{\delta T_m}$ from the incident and outgoing energies, from the stopping power of the absorber, and from the detector angle of acceptance. A typical value for $\overline{\delta T_m}$ of 650 keV is obtained for 40 MeV protons losing 32 MeV in a gold absorber and seen under a detector angle of ±29°. (auth)

29805 MEASUREMENT OF THE ENERGY OF PROTONS FROM 300 TO 2050 keV USING NUCLEAR MAGNETIC RESONANCE. Sorriaux, A.; de la Fourniere, B.; Ritaine, J. (Centre d'Etudes Nucleaires, Saclay, France). Nucl. Instrum. Methods, 62: 61-7(June 1, 1968). (In French).

Experimental apparatuses described in this article were built in order to fit out the new 2-MeV Van de Graaff accelerator. A nuclear magnetic resonance flux analyser is described. A common oscilliograph and frequency meter were used and a simple oscillator system was built. Also a target thickness control system is described. Calibration was done with the $^{27}Al(p\gamma)^{28}Si$ resonance at 991.87 keV. (auth)

29806 METHOD FOR PREPARING STABLE CARBON FOILS. Schwarzbach, E.; Michel, F. (Kernforschungszentrum, Karlsruhe, Ger.). Nucl. Instrum. Methods, 62: 112(June 1, 1968). (In German).

A technique for preparing stable carbon foils with 2 mg/cm^2 has been developed. Their characteristics and application are described. (auth)

29807 MITSUBISHI MEDICAL LINEAR ACCELERATOR. 1st REPORT: 6 Mev X-RAYS. Asakawa, Hiroshi; Ida, Yasuo (Miyagi Adult Diesease Center, Japan). Nippon Igaku Hoshasen Gakkai Zasshi, 27: 1411-17(Feb. 1968). (In Japanese).

Mitsubishi medical accelerator was installed in the Miyagi Adult Disease Centre, in 1967. The results of performance tests and the physical characteristics of the 6-MeV x rays are summarized as follows. The maximum output of equalized x rays was about 400 R/min at a point of 100 cm from the target. The generated energy of x ray beams was about 6 MeV and the effective energy was 1.9 MeV. Dose rate of x rays was kept stable with the fluctuation of 1.5% in fixation radiotherapy and 3% in rotation. X-ray beams were the most homogeneous at the depth of 10 cm in water. Inhomogeneity in the dose distribution was less than 2.4% in 20 × 20 cm of radiation field. Surface dose, depth dose, and tissue air ratio of 6-MeV x rays were measured in several fields. The data of each measurement show the advantages of supervoltage radiation. Isodose charts and depth dose curves were made of the measured values in various fields. Dose distribution of 6 MeV x rays is discussed in some clinical cases. (auth)

29808 MODEL FOR THE MOTION OF A CHARGED PARTICLE IN A CYCLOTRON. Brinkman, H.; Otter, S. (Rijksuniversiteit, Groningen, Netherlands). Ned. Tijdschr. Natuurk., 34: 66-72(Mar. 1968). (In Dutch).

For demonstration purposes a cyclotron model is developed, consisting of a conical pendulum stimulated by periodic electrical forces, through which the suspended mass describes circular orbits of increasing radius. With a transparent model the particle acceleration in a cyclotron can be projected on a screen. (auth)

29809 PNEUMATIC IRRADIATION DEVICE WITH THE LYON SYNCHROCYCLOTRON. Martin, J.; Tousset, J. (Institut de Physique Nucleaire, Lyon). Rev. Phys. Appl., Suppl. J. Phys., 3: 63-6(May 1968). (In French).

A pneumatic tube device for rapid, automatic positioning and removal of targets in the vacuum chamber of the external beam of a synchrocyclotron is described. The target can be returned to the radiochemical laboratory, a distance of 140 meters, within one minute after the end of the irradiation. (auth)

29810 NEW FORM OF EXPLOITATION OF CYCLOTRON U-120. Dobias, J.; Fukatko, T.; Hrda, A.; Karban, O.; Krivanek, M.; Kult, K. (Nuclear Research Inst., Rez, Czech.). Czech. J. Phys., 18: 640-3(1968).

Experiments carried out on the Nuclear Research Institute cyclotron U-120 showed that the energy of the output beam can be changed in the region 6.2–7.2 MeV/nucl without additional correction of the radial slope of the magnetic field (e.g., with the use of ferromagnetic shims suitable for an energy of 6.7 MeV/nucl). Using a combination of ring and disc shims, ions of atomic hydrogen were accelerated in the energy region 8.5–10.7 MeV and ions of $_3He^{2+}$ with energy 21 MeV. The intensities of these beams, except $_3He^{2+}$ having been accelerated in the economical regime of the ion source, reached as much as 100 μA behind the deflector. The possibility of smooth regulation of the energy without changing the classical character of the accelerator is also discussed. (auth)

29811 NO-LOAD CURRENT OF A CHARGED-PARTICLE ACCELERATOR. Shembel', B. K. At. Energ. (USSR), 23: 285-8(Oct, 1967). (In Russian).

At high beam currents the no-load power may equal or even be less than the power going into particle acceleration. The ratio of the no-load power to the energy per unit charge acquired by the particle can be taken as an estimate of the quality of the accelerating system in the accelerator. This ratio has the dimensions of current, and is called the no-load current, since it is determined by the losses in the system for a certain mode of operation. The total equivalent current is equal to the no-load current plus the beam current: $I = I_{NL} + I_B$. The efficiency of the accelerating system is $\eta_c = I_B/(I_B + I_{NL})$. The no-load current is applicable to the accelerator as a whole, and can be used for the direct comparison of linear and cyclic accelerators. A comparison of the data of various accelerators shows that the no-load current is a basic energy characteristic along with the beam current and particle energy. The no-load current is the only measure of estimating the energy qualitites of the high-frequency accelerating system. The no-load current of linear machines is proportional to the linear acceleration and inversely proportional to the linear shunt resistance. For energies on the order of 80 MeV the no-load current is about 50 ma, and for energies up to 200 MeV it may exceed 100 ma for certain sections of the machine, but is 70 to 85 mA for the accelerator as a whole. The no-load current may be as low as 28 mA for a cyclotron with separated orbits. The data indicate that at beam currents of 50 mA a cyclotron with separated orbits is more economical than a linear accelerator. These differences become smaller at beam currents of 100 mA and higher. (TTT)

29812 NSRL ON-LINE COMPUTER SYSTEM. Waugh, John B. S.; Yonda, A. H, Jr. (Univ. of Rochester, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: 129-34(Feb. 1968).

From 14th Nuclear Science Symposium, Los Angeles. See CONF-671026.

The on-line computer system recently put into operation for use in low-energy nuclear physics research using a 20-MeV Emperor tandem Van de Graaff accelerator is described. (B.G.D.)

29813 PARTICLE SEPARATION AT HIGH ENERGIES. II. RADIO-FREQUENCY SEPARATION. Montague, B. W. (CERN, Geneva). Prog. Nucl. Tech. Instrum., 3: 1-66(1968).

Developments in radiofrequency particle separation at high energies are presented. General principles of rf particle separation, deflecting waves and structures, optics of rf separated beams, engineering aspects, operation, and future developments are discussed. (W.H.K.)

29814 PERTURBED PHASE MOTION IN A SYNCHROCYCLOTRON DUE TO SPACE CHARGE. Kullander, S. (CERN, Geneva). Nucl. Instrum. Methods, 62: 169-72(June 15, 1968).

The phase motion in a synchrocyclotron in absence of space charge is known from the single-particle phase equation. With a narrow accelerating gap, the starting phase interval remains as

in a cyclotron, rather constant up to a radius where the effects of the phase oscillations set in and a so called bucket develops. In the presence of azimuthal space charge forces the single-particle phase equation is altered. Due to this the starting phase interval in the cyclotron-like region is compressed and the bucket area in the synchrotron-like region is reduced. These unwanted effects can be reduced by choosing high voltages and repetition frequencies. (auth)

29815 PRODUCTION OF A NANOSECOND-PULSED He^{++} BEAM FROM A 5.5-MeV VAN DE GRAAFF. Towle, J. H.; Howe, F. A.; James, G. (Atomic Weapons Research Establishment, Aldermaston, Eng.). Nucl. Instrum. Methods, 62: 77-81 (June 1, 1968).

A gas stripper canal has been installed in the accelerating tube of a 5.5 MeV Van de Graaff. At full energy 20% of injected He^{+} ions are stripped and are accelerated to 10.5 MeV. At this energy 2 μA analysed of He^{++} are readily obtained. With the klystron buncher in operation 0.5 μA mean current of He^{++} beam with burst width <1.5 ns at 5 Mc/s repetition rate is obtained on target. Normal use of the machine with singly charged beam is unaffected. (auth)

29816 PRODUCTION OF MULTIPLY CHARGED IONS OF ARGON, KRYPTON, ZENON, AND TUNGSTEN FROM ARC DISCHARGED ION SOURCE ON STAND. Pasyuk, A. S.; Tret'yakov, Yu. P.; Gorbachev, S. K. At. Energ. (USSR), 24: 21-5(Jan. 1968). (In Russian).

From cyclotron sources of multiply charged ions with heated cathodes, using oscillating arc discharge, in stand tests, multiply charged ions of Ar, Kr, Xe, and W were obtained. The pulse current of Ar^{8+} ions was 100 μA, Kr^{10+} 22 μA, Xe^{12+} 100 μA, and W^{12+} 50 μA. The dependence of the ion yield on the discharge voltage and current and on the quantity of working gas fed to the discharge chamber was determined. The ion yields of Ar, Kr, and Xe with respect to the degree of charge were compared with the yields of these ions from sources with refrigerated cathodes. (tr-auth)

29817 RESONANCE BUILDUP OF RADIAL OSCILLATIONS OF ELECTRONS IN A BETATRON. Ivanov, D. P.; Komar, A. P.; Korobochko, Yu. S. (Leningrad Polytechnic Inst.). Zh. Tekh. Fiz., 37: 2213-15(Dec. 1967). (In Russian).

Experimental techniques described elsewhere by S. G. Denisov and the authors (ZhTF, 30: 31(1960)) have been employed to investigate the buildup in a 15-MeV betatron of the radial oscillations that result in the electrons striking the target prematurely. In the experiments the effect of the position of a specially designed probe on the intensity of x rays from the target and from the probe itself was observed. It was found that in the investigated betatron the radial oscillations grew rapidly until their amplitude reached about 1.5 cm, maintained approximately that amplitude for about 250 μsec, and again began rapidly to grow until the electrons struck the target. It is hypothesized that the radial oscillations are the resonance oscillations discussed by E. D. Courant (J. Appl. Phys., 20: 611(1949)) and J. D. Lawson (Nature, 165: 109(1950)) that occur when the inhomogeneity index n of the magnetic field becomes equal to 0.75, and that the oscillations arise in the betatron because the radius of the region where n = 0.75 decreases as a result of saturation of the outer edges of the pole pieces until it becomes equal to the radius of the equilibrium orbit. It is suggested that the electron beam in the betatron can be prevented from striking the target prematurely by so designing the betatron that the radius of the equilibrium orbit remains always smaller than the radius of the n = 0.75 region. The authors thank S. G. Denisov and V. F. Kovel' for assistance with the work. (ATD)

29818 SOME REMARKS CONCERNING THE PROTON FLUX MONITOR REACTION $^{27}Al(p,3pn)^{24}Na$. Brandt, R.; Gfeller, Ch.; Stoetzel-Riezler, W. (CERN, Geneva). Nucl. Instrum. Methods, 62: 109-11(June 1, 1968).

The high-energy proton flux monitor reaction $^{27}Al(p,3pn)^{24}Na$ is influenced by secondary particles. It is shown that this influence is small, as long as the total target thickness T is T < 500 mg/cm^2. (auth)

29819 AN IMPROVED LAMB-SHIFT SOURCE FOR POLARIZED NEGATIVE HYDROGEN IONS. Meiner, H.; Michel, G.; Corrigan, K. (Univ. of Notre Dame, Ind.). Nucl. Instrum. Methods, 62: 203-4(June 15, 1968).

An improved source for polarized negative hydrogen ions is described. The polarization is increased by a simple method using static fields only. (auth)

29820 BEAM SWITCHYARD COOLING WATER SYSTEM (Engineering Materials). (Stanford Linear Accelerator Center, Calif.). (CAPE-1707).
20 drawings.

The cooling water system for the beam switchyard of the Stanford Linear Accelerator is described. Piping diagrams are included for the power supply for the pulsed magnet; C-1 collimator; slits; beam dumps; surge tanks; and the heat exchangers for the collimators and slits. See also CAPES-1483, 1514, 1648, 1710, and 1711. (For details see TID-4100). (F.S.)

29821 PROTECTION COLLIMATORS (Engineering Materials). (Stanford Linear Accelerator Center, Calif.). (CAPE-1711).
5 drawings.

Collimators for the Stanford Linear Accelerator are described. The collimators define the spacial extent of the beam, form aperture stops for the beam transport system, and protect magnets and other equipment from physical damage by the beam. The collimators are designed to withstand beam damage in beam misteering or beam misalignment. See also CAPE-1707. (For details see TID-4100). (F.S.)

29822 QUADRUPOLE TRIPLETS MAGNET (Engineering Materials). (Stanford Linear Accelerator Center, Calif.). (CAPE-1708).
15 drawings.

Quadrupole triplets consisting of three quadrupole magnets, one with an effective length of 8 in. and two of opposite polarity with an effective length of 4 in. are described. The triplets are placed axially in the drift sections between the accelerating sectors of the accelerator. They operate as a spaced triplet so that a beam traverses one of the magnets with 4 in. length at one polarity, then the 8 in. at the opposite polarity, and then the other 4 in. The magnets are identical except for the difference in length. The 4 in. magnets are designated QA and the 8 in. QB. The design magnet strength for the QA type is 10 kilogauss and for the QB type 20 kilogauss. (For details see TID-4100 Suppl. 45). (F.S.)

29823 SLAC INJECTOR SYSTEM COMPONENTS (Engineering Materials). (Stanford Linear Accelerator Center, Calif.). (CAPE-1709).
10 drawings.

The electron gun and the grid pulser of the injector system of the Stanford Linear Accelerator are described. The electron gun, which is similar to a triode vacuum tube produces electrons with an energy of 80 keV. The grid pulser controls the rate and direction of the beam pulses. (For details see TID-4100 Suppl. 45). (F.S.)

29824 SURGE TANK RECOMBINER (Engineering Materials). (Stanford Linear Accelerator Center, Calif.). (CAPE-1710).
14 drawings.

A surge tank recombiner is described which is used in the Stanford Linear Accelerator. The recombiner burns any hydrogen which is dissolved in water that was used in cooling devices where radiation was present. (For details see TID-4100). (F.S.)

29825 CALUTRON ION SOURCE HAVING A MOVABLE BAFFLE FOR IMPROVING THE ION OUTPUT. Lee, J. V. (to United States Atomic Energy Commission). U. S. Patent 3,382,359. May 7, 1968.

An improved calutron ion source is described in which a perforated movable baffle is utilized within the ionization chamber of the source and means are provided for adjusting the position of the baffle such that signals derived from the baffle, as viewed on an oscilloscope, indicate a minimum in the amplitudes of oscillations when the baffle has been positioned properly thereby permitting a higher gas feed to the source which results in a substantial increase in the ion output from the source. (AEC)

29826 POSITIVE ION-SOURCE HAVING ELECTRON RETAINING MEANS. Consoli, Terenzio; Geller, Richard (to Commissariat a l'Energie Atomique). U. S. Patent 3,376,469. Sept. 30, 1965. Priority date Oct. 14, 1964, France.

An accelerated jet of positively and negatively charged particles is passed through a coil generating a magnetic field parallel to the long axis of the jet and having its intensity decreasing in the direction of flow to diverge negatively charged particles. The jet then passes through spaced parallel plates having openings in the cross-section of the jet with the upstream plate positively charged and the downstream plate negatively charged so that the upstream plate captures negatively charged particles. (auth)

29827 RESONANT CAVITY-TYPE MONITOR FOR MEASURING THE BUNCH LENGTH OF A BEAM OF CHARGED PARTICLES IN A PARTICLE ACCELERATOR. Koontz, Roland F.; Miller, Roger H. (to United States Atomic Energy Commission). U. S. Patent 3,383,590. May 14, 1968.

A beam bunch monitor is described which is inserted as a section of waveguide in a particle accelerator, and having a first cavity tuned to the fundamental beam bunch frequency, and a sec-

ond cavity tuned to a selected harmonic. Fundamental and harmonic signals induced in the respective cavities by the beam bunches are extracted and applied to arithmetic circuits to derive an output signal equal to $(P_F - P_H)/P_F$, where P_F is the power of the extracted fundamental signal, and P_H is the power of the extracted harmonic signal. The derived output signal is proportional to the square of the bunch length and is therefore an indication of bunch length. (AEC)

PHYSICS (NUCLEAR)

Neutron Interactions with Matter

Refer also to abstracts 28102, 28178, 28242, 29894, 30155, 30329, and 30370.

29828 (BNL-12417) COMPILATION OF NEUTRON-INDUCED THRESHOLD REACTIONS. Magurno, B. A. (Brookhaven National Lab., Upton, N. Y.). [1965]. 16p. (CONF-680411-2). Dep. CFSTI.

From Conference on Small Accelerators, Oak Ridge, Tenn.

Data for a selected set of neutron-induced threshold reactions have been collected. The reactions have been plotted as functions of energy, and fits are being made. Examples are shown and discussed. (auth)

29829 (GA-8551) FAST NEUTRON SPECTRA IN MULTIPLYING AND NON-MULTIPLYING MEDIA. Neill, J. M.; Russell, J. L. Jr.; Moore, R. A.; Preskitt, C. A. (Gulf General Atomic, Inc., San Diego, Calif.). Feb. 23, 1968. Contract AT(04-3)-167. 17p. (CONF-680307-33). Dep. CFSTI.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C.

Fast neutron spectra were measured at various positions in spheres of depleted uranium and 93.2% enriched uranium, and these data were used to provide integral checks on the accuracy of neutron cross sections and computational methods. The data cover the energy range between about 10 keV and 15 MeV and were obtained using three flight path lengths, 45, 50, and 210 meters. The detectors used consisted of a 5-in. diameter NE-213 proton-recoil detector for fast neutrons and a 5-in. diameter NE-908 lithium glass detector for intermediate energy neutrons. The pulsed source for the measurements was obtained by impinging the beam from the Gulf General Atomic Linear Electron Accelerator onto tungsten or uranium targets. Several different types of calculation have been compared with the measurements, including multigroup transport theory, and two different sets of cross sections have been used. The measured spectra in the ^{235}U sphere are consistently softer than the calculated values. The measured spectra in the ^{238}U sphere are accurate enough to permit one to choose the better of the two cross section sets. (auth)

29830 (GA-8602) NEUTRON CROSS-SECTION MEASUREMENTS. Summary Report, March 1, 1967-February 29, 1968. Fricke, M. P.; Lopez, W. M. (Gulf General Atomic, Inc., San Diego, Calif.). Mar. 26, 1968. Contract AT(04-3)-167. 47p. Dep. CFSTI.

An investigation of the capture cross section of Gd was initiated; preliminary resonance parameters are presented for ^{155}Gd and ^{157}Gd. Developments in methods for analyzing time-of-flight data are also reported, together with improvements in experimental facilities for time-of-flight measurements at the linear accelerators. A CDC-1700 computer was installed at the linear accelerator facility as part of an on-line data acquisition system. (D.C.W.)

29831 (KAPL-M-6741) 05R USERS MANUAL. Ellis, C. L.; MacMillan, D. B. (Knolls Atomic Power Lab., Schenectady, N. Y.). Dec. 1, 1967. Contract W-31-109-Eng-52. 63p. Dep. CFSTI.

The 05R code is a neutron Monte Carlo program originally written at ORNL and extensively revised at KAPL. The objectives with which 05R was designed are these: to use a highly accurate mathematical model for neutron behavior; to permit accurate representation of a wide variety of geometrical configurations; and to offer a general-purpose variance reduction scheme, and maximum flexibility in analysis of generated neutron histories, in order that the program will be applicable to a wide variety of calculations. 05R and related programs are described, and the input required by each program is specified. (auth)

29832 (UCRL-50400(Vol.1)) ECSIL: A SYSTEM FOR STORAGE, RETRIEVAL, AND DISPLAY OF EXPERIMENTAL NEUTRON DATA. Howerton, R. J.; Cahill, W. J.; Hill, K. L.; Thompson, D. W.; Perkins, S. T. (California Univ., Livermore. Lawrence Radiation Lab.). Jan. 11, 1968. Contract W-7405-eng-48. 94p. Dep. CFSTI.

A description of the Experimental Cross Section Information Library (ECSIL), a system written primarily in basic Fortran II for the storage, retrieval, and tabular or graphical display of experimental constants associated with neutron-induced nuclear reactions, is presented. (auth)

29833 (WAPD-TM-690) NUMERICAL COMPARISON OF NEUTRON TRANSPORT APPROXIMATIONS FOR APPLICATION AT ENERGIES ABOVE 0.8 MeV (LWBR DEVELOPMENT PROGRAM). Freeman, L. B.; Ryals, H. W. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Apr. 1968. Contract AT-11-1-GEN-14. 28p. Dep. CFSTI.

The simplified $P_1(SP_1)$ and modified P_2 (MP_2) transport approximations have been considered for use as practical nuclear design tools, replacing diffusion theory in the first few-group of a four-group scheme. Two numerical comparisons of two-dimensional systems indicate that SP_1 can be a satisfactory design tool for situations where the total cross section is slowly varying and the geometry is not too severe. The MP_2 approximation has certain computing advantages, but does not yield as uniform an improvement over P_1 as SP_1 yields. (auth)

29834 (WAPD-TM-743) TWIGL: A PROGRAM TO SOLVE THE TWO-DIMENSIONAL, TWO-GROUP, SPACE-TIME NEUTRON DIFFUSION EQUATIONS WITH TEMPERATURE FEEDBACK. Yasinsky, J. B.; Natelson, M.; Hageman, L. A. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Feb. 1968. Contract AT-11-1-GEN-14. 56p. Dep. CFSTI.

The computer program TWIGL, a two-dimensional, two-group, space-time diffusion theory program for rectangular or cylindrical geometries, is described. From zero to six groups of delayed neutron precursors may be used. Temperature feedback effects are accounted for via a one-pass, no-boiling thermal-hydraulic model. The relevant differential equations are represented by space-time difference equations which are solved at each time step by an accelerated iterative procedure. The governing equations, solution technique, and input information are described. (auth)

29835 CALCULATIONS OF THERMALIZATION OF PULSED NEUTRONS BY FEW-POLE EXPANSION METHOD. Hoshino, Tsutomu; Wakabayashi, Jiro. Tech. Rep. Eng. Res. Inst., Kyoto Univ., No. 136, 1-8(Dec. 1967).

The "few-pole expansion method" gives an approximate solution of general space-dependent linear kinetics. This method is applied to a slowing down and thermalization problem of pulsed neutrons. A numerical example is illustrated for the case of hydrogen free gas. Even an expansion with only two terms can give a good agreement with some experiment. (auth)

29836 CONTRIBUTION TO THE SKYSHINE STUDY. Ladu, M.; Pelliccioni, M.; Picchi, P.; Verri, G. (CNEN, Frascati, Italy). Nucl. Instrum. Methods, 62: 51-6(June 1, 1968).

The results obtained by application of the Monte Carlo method to the skyshine study are described. We found that the neutron fluence ϕ per primary neutron decreases with distance r according to the laws $\phi(r) = Ar^{-\alpha}$ for distances between 20 m and 300 m, and $\phi(r) = B \exp(-r\lambda)$ for greater distances. The dependence of the coefficients A, B, α, and λ, on a number of different parameters is studied. The results are compared with the Lindenbaum theory, and a good agreement is found. The effects of shields over the intensity and energy distribution of the diffused neutrons are also studied. Finally, the values of the back-scattering coefficient of the earth's surface is obtained. (auth)

29837 CROSS SECTION FOR MULTI-PHONON SCATTERING OF NEUTRONS BY CRYSTALLINE POLYETHYLENE. Kitagawa, Teizo; Miyazawa, Tatsuo (Osaka Univ.). J. Polym. Sci., Part B, 6: 83-6(Jan. 1968).

The cross sections for multiphonon scattering of neutrons by the crystal vibrations of polyethylene were calculated. The incoherent scattering from hydrogen nuclei is predominant; accordingly, the inelastic cross sections of hydrogen nuclei were treated on the basis of Born's first approximation and Fermi's pseudopotential (Phys. Rev., 65: 1(1944)). (D.C.W.)

29838 CURVE FITTING AND STATISTICAL TECHNIQUES FOR USE IN THE MECHANISED EVALUATION OF NEUTRON CROSS SECTIONS. Horsley, A.; Parker, J. B.; Price, J. A. (Atomic Weapons Research Authority, Aldermaston, Eng.). Nucl. Instrum. Methods, 62: 29-42(June 1, 1968).

A cubic spline curve fitting method and a statistical theory of unknown systematic errors are combined to give a practical computer-orientated method of evaluating neutron cross sections. Particular attention is paid to reconciling sets of discordant data. The input data and evaluated curve can be displayed on a CRT graphical display unit. Among program output examples given are evaluated curves for several cross sections of ^{10}B. (auth)

29839 DESIGN DATA FOR ^{252}Cf NEUTRON SOURCE EXPERIMENTS. Nichols, Jere P. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. Nucl. Appl., 4: 382-7 (June 1968). (ORNL-P-3496).

Data that permit estimation of the available neutron fluxes and shielding requirements of irradiation devices that use a ^{252}Cf neutron source are presented. A practical irradiation device, suitable for neutron activation analysis and capable of producing a thermal flux of ~0.02 cm^{-2} per source neutron, can be constructed by placing the source at the center of an equilateral cylinder or cube of high-density polyethylene having diameter or width of ~1 ft. Biological shielding requirements vary from ~2 ft of normal concrete or water for a source of 1 mg ^{252}Cf to ~5 ft of dense, hydrogenous concrete for a source of 1 g ^{252}Cf. (auth)

29840 FLUCTUATIONS AND SCATTERING PROCESSES OF SLOW NEUTRONS AND LIGHT IN ANTIFERROMAGNETS IN A STRONG MAGNETIC FIELD. Akhiezer, I. A.; Bolotin, Yu. L. Sov. Phys.-Solid State (Engl. Transl.), 9: 2016-21(Mar. 1968). Translated from Fiz. Tverd. Tela, 9: 2559-67(Sept. 1967).

The fluctuations and scattering processes of slow neutrons and electromagnetic waves in antiferromagnets located in a strong magnetic field $H_0 \sim T_N/g\bar{h}$ (T_N is the Néel temperature, $g\bar{h}$ the Bohr magneton) are investigated, taking into account the interaction of elastic waves and oscillations of the magnetic moments. Correlators of functions characteristic of antiferromagnetic quantities (the magnetic moment, the magnetic field and induction, the crystal density) are defined, both far from and near to magnetoacoustic resonance. It is shown that the elastic fluctuations which accompany a spin wave have a considerably greater intensity when a magnetic field is present than when it is not. Similarly, a strong magnetic field leads to a considerable increase in the amplitudes of magnetic fluctuations which accompany a longitudinal sound wave. The influence of a strong magnetic field on the scattering of electromagnetic waves in antiferromagnets is also studied. It is shown that the intensity of the magnon satellites in the spectrum of light scattered in a strong magnetic field is significantly greater than in the absence of the field. It is also demonstrated that when the magnetic field is approximated by its resonance value, the spectral distribution of light scattered in an antiferromagnet and the angular distribution of scattered neutrons are changed substantially. In principle this permits one to observe magnetoacoustic resonance in antiferromagnets by light scattering or by slow-neutron scattering. (auth)

29841 MULTIGROUP SYSTEM OF INTEGRAL EQUATION FOR NEUTRON TRANSPORT DESCRIPTION. Bergel'son, B. R.; Rumyantsev, I. A.; Torlin, B. Z. At. Energ. (USSR), 24: 28-32 (Jan. 1968). (In Russian).

A multigroup system of kinetic equations was put into integral form. For scattering indicatrices, the transport approximation was assumed. The system of integral equations obtained was used in the composition of a program for computers. The results of the calculation of the spectra of fast neutrons in Pb, Fe, and graphite were compared with experimental data. (tr-auth)

29842 NEUTRON PROPAGATION IN REINFORCED PLASTICS. Van Fo Fi, G. A. Dopov. Akad. Nauk Ukr. RSR, Ser. A, No. 2, 135-8(Feb. 1968). (In Ukrainian).

A problem is considered on neutron propagation in a diffusion approximation in reinforced media with a regular structure. A theorem is proved on the structure of a stationary particle flow in an absorbing heterogeneous media. Reduced absorption cross sections and diffusion coefficients of neutrons are established in systems of the fibre-glass reinforced plastic type. (auth)

29843 NEUTRONICS AND PHYSICS: AN EXAMPLE OF SCIENTIFIC CO-OPERATION. Smets, Henri B. OECD (Organ. Econ. Coop. Develop.) Observ., No. 28, 10-12(June 1967).

The programs of the OECD European Nuclear Energy Agency to further international co-operation in particular fields of nuclear research are outlined. The aim of this co-operation has been to co-ordinate research programs in member countries, and also to promote the speedier exchange of highly specialized information through the medium of international scientific committees. The work of 2 such committees, is described, particularly that of the European-American Nuclear Data Committee and the European-American Committee on Reactor Physics, which have enabled close contacts to be maintained between specialists in Europe, North America and Japan who are jointly engaged in furthering basic knowledge. (BBB)

29844 NUCLEAR EXPLOSIVE AS A HIGH NEUTRON FLUX MACHINE. Dorn, David W. (Univ. of California, Livermore). Ark. Fys., 36: 41-5(1967).

From International Symposium on Why and How Should We Investigate Nuclides Far Off the Stability Line, Lysekil, Sweden. See CONF-660817.

The use of thermonuclear explosions as a high-flux source of neutrons for heavy element production is briefly reviewed. Results obtained in the Anacostia and Par events are discussed. (S.F.L.)

29845 PERTURBATION OF SLOWING-DOWN DENSITY DUE TO A LOCAL ABSORBER IN A PULSED FINITE MEDIUM. Navalkar, M. P.; Iyengar, S. B. D. (Bhabha Atomic Research Centre, Trombay, India). J. Nucl. Energy, 22: 259-61(Apr. 1968).

In carrying out neutron spectrum measurements using a lead spectrometer small neutron-absorbing samples are introduced into the center of the Pb assembly, thus reducing the slowing-down density. A theoretical and experimental assessment showed the perturbation to be small. (UK)

29846 RECURSION FORMULAE FOR SEMI-ANALYTICAL MULTIPLE SCATTERING CALCULATIONS IN SLAB GEOMETRY. Froehner, F. H. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Nucl. Instrum. Methods, 62: 113-14 (June 1, 1968). (GA-8187).

The extraction of cross sections from absorption or capture data requires multiple scattering calculations. Often the Monte Carlo method is the easiest way to perform these calculations, as for example in the case of resonance cross sections. Two types of averages are involved: angular averages and averages over free path distributions. It is shown that for infinite slab samples the free path averages can be calculated analytically, and convenient recursion formulae are given for the case of absorption and scattering. (auth)

29847 RELATIVE CALIBRATION OF NEUTRON SOURCES BY A POINT DETECTOR. Notea, A.; Nir-El, Y. (Soreq Nuclear Research Center, Yavne, Israel). Nucl. Instrum. Methods, 62: 43-4(June 1, 1968).

A new procedure for the relative calibration of neutron sources having different energy spectra, based on equating the effective centers for each neutron source is presented. An example of the procedure is given. (auth)

29848 SPECTRA OF MONOENERGETIC NEUTRON TRANSPORT OPERATOR IN SPHERICAL GEOMETRY. Shkurpelov, A. A. Zh. Vychisl. Mat. i Mat. Fiz., 8: 459-67(Mar-Apr. 1968). (In Russian).

A one-velocity nonstationary kinetic equation with an anisotropic scattering indicatrix for spherical geometry was obtained. The problem was reduced to an equation which was solved by a method similar to that of K. M. Case (Ann. Phys., 9: 1-23(1960). Equations were obtained for approximate calculations of the eigenvalues. (R.V.J.)

29849 STUDY OF NEUTRON THERMALIZATION IN LEAD USING A PULSED NEUTRON SOURCE. Navalkar, M. P. (Bhabha Atomic Research Center, Trombay, India). J. Nucl. Energy, 22: 251-5(Apr. 1968).

By recording capture γ intensity from a thick cadmium sample and normalizing it with a $1/v$ detector such as BF_3 both flux and average velocity as a function of slowing down time were determined. The experimental data were analyzed both on classical temperature difference and energy mode concepts to yield the temperature relaxation time constant (τ_t) and thermalization time constant (τ_{th}). It is seen that the measured values of τ_t and τ_{th} are in agreement as predicted by theory and the measured value of τ_t agrees with the calculated value based on that heavy gas model which in lead is consistent in view of low Debye temperature (88°K). (auth) (UK)

29850 STUDY ON THE SMALL-ANGLE SCATTERING OF THERMAL AND COLD NEUTRONS BY NICKEL AND GRAPHITE. Kim, Huhn-jun (Atomic Energy Research Inst., Seoul). J. Nucl. Sci. (Seoul), 7: No. 1, 1-7(Oct. 1967).

Experimental small-angle scattering effects of two extreme cases of neutron wavelengths by powders are compared with theory. Using the TRICA Mark II reactor, thermal neutrons (1.3Å) from the crystal monochromator and graphite-filtered cold neutrons (11. 4Å were scattered by reactor graphite for diffraction dominant range and nickel powder (150 to 325 mesh) for refraction dominant range. Measured broadening effects are found to give a satisfactory account of the theoretical results. The small-angle scattering cross section of graphite, assuming the effective black size of 0.1 microns, results in 6.28×10^{-14} cm^2/particle at 1.3Å. For the cold neutrons, however, 0.1 micron black size corresponds to intermediate range, and comparison of measured fraction and calculated faction $f = 1 - \exp(-Np^0d)$ revealed appreciable discrepancy owing to, may be, the interference

between neutrons scattered from adjacent particles in a conglomerated powder particles. (auth)

29851 THE MEASUREMENT OF MEAN FREE PATH λ_s USING A SLOWING-DOWN TIME LEAD SPECTROMETER IN THE 1 TO 10 eV ENERGY REGION. Navalkar, M. P.; Chandramoleshwar, K.; Ramkrishna, D. V. S. (Bhabha Atomic Research Centre, Trombay, India). J. Nucl. Energy, 22: 261-2(Apr. 1968).

Short bursts of approximately monoenergetic neutrons were obtained from an accelerator by the (d, t) reaction. A BF_3 proportional detector was used to measure the neutron density as a function of time in the range 200 to 500 μsec for a large assembly (2 m. cube). A mean lifetime of 890 ± 133 μsec was found from a separate experiment, and a value of 2.61 ± 0.2 cm for the mean free path of Pb was obtained. (UK)

29852 THE TEMPERATURE AND FREQUENCY DEPENDENCE OF THE INELASTIC NEUTRON SCATTERING FROM AN ISING MAGNET. Allan, G. A. T.; Betts, D. D. (Univ. of Alberta, Edmonton). Can. J. Phys., 46: 799-802(Apr. 1, 1968).

The magnetic inelastic scattering of neutrons from a spin-½ Ising system is considered. For the two-dimensional plane square lattice, the exact energy distribution of the scattering is obtained at all temperatures. It consists of a number of discrete levels, the envelope of which varies most markedly in the critical region. Some qualitative projections are also made concerning three-dimensional systems. For both two- and three-dimensional Ising models there can be no wave-vector dependence of the inelastic scattering function because there is correlation only between z components of the spins on different sites. (auth) (Canada)

29853 ANALYTICAL STUDY OF THERMAL NEUTRON SPECTRA IN TWO-DIMENSIONAL HOMOGENEOUS REACTOR CELLS. Luoma, John David. Evanston, Ill., Northwestern Univ., 1967. 190p.

Thesis.

The space-energy dependent scalar flux is determined analytically for epithermal and thermal neutrons in a reactor consisting of a hexagonal lattice of coolant holes in a homogeneous mixture of fuel and moderator. All media are treated as a monatomic gas with respect to elastic scattering. The microscopic absorption cross section is taken to be inversely proportional to the neutron speed. The scalar flux is represented radially by modified Bessel functions ranging in order from zero to 60, azimuthally by a summation over cosines, and energetically by polynomials and negative exponentials. For the fuel-moderator mixture, ^{235}U and ^{12}C, and coolant, ^{1}H, the spectra are found to peak around .4kT, fall then rise between 1.2 and 3kT, and decrease after 3kT. For low energies and small angles, the scalar flux radially increases in the fuel-moderator mixture; at higher energies, the flux decreases. For low energies and large angles, the scalar flux radially increases then decreases in the fuel-moderator mixture; at higher energies, the flux decreases then increases. For low energies and a fixed radial position, the flux decreases as the aximuthal angle increases; for higher energies, the flux increases with increasing angle. In the coolant, the scalar flux is only a function of energy. Computer codes are developed to evaluate double integrals over a product of energy dependent expansion coefficients for the macroscopic differential elastic scattering cross section and the energy dependence of the thermal scalar flux. Also, a code is developed to determine a variable number of coefficients for terms representing the radial dependence of the scalar flux. (Disser. Abstr.)

29854 APPLICATION OF VARIATIONAL METHODS TO THE PULSED NEUTRON PROBLEM. Jenkins, James Douglas. Troy, N. Y., Rensselaer Polytechnic Inst., 1967. 178p.

Thesis.

The behavior of pulsed neutron systems whose decay is not always dominated by a fundamental mode is investigated. Such systems include large ranges of fast multiplying assemblies and of thermal moderating assemblies. A complete numerical eigenfunction-eigenvalue analysis is carried out for several fast multiplying assemblies. Exact solutions are obtained for the GODIVA and SUAK systems and for natural uranium assemblies. These results are compared with experiment and are used to provide understanding of the physical processes governing the system response and to provide a basis of comparison for variational methods which are developed. A variational functional is developed which is capable of estimating the decay rate of the dominant reproducing mode of the system both in the case when this mode is a true fundamental or lowest mode and in the case when it is a pseudo-fundamental or higher mode. The method also yields a good approximation to the associated eigenfunction. The method has been applied to both beryllium and fast multiplying assemblies and gives good agreement with the exact calculated results. A second variational method, based on the least squares variational functional, is developed to describe the two-dimensional time-energy flux of such systems. Comparison with exact calculations, both for thermal non-multiplying and fast reproducing assemblies, shows good agreement. The variational method is applicable over a wide range of bucklings or subcritical reactivities and gives a good representation of the time-energy behavior of the flux over a time range when measurements can be taken. The method works equally well for systems with a dominant fundamental or pseudo-fundamental mode. In addition, it is shown that reactivity measurements utilizing the pulsed source techniques and present analytical techniques are not clearly interpretable for fast multiplying systems for which K_{eff} is less than 0.7. However, for more reactive systems, the absence of a strong fundamental mode does not preclude the use of pulsed source techniques for reactivity measurements as long as a clearly defined pseudo-fundamental mode decay eigenvalue is observable. (Diss. Abstr.)

29855 THERMAL NEUTRON SPECTRA AND INTEGRAL PARAMETERS IN HETEROGENEOUS SYSTEMS. Bulmer, Joseph James. Troy, N. Y., Rensselaer Polytechnic Inst., 1967. 201p.

Thesis.

An integral method is developed to determine energy dependent neutron spectra and integral parameters such as the thermal utilization factor, f and the thermal reproduction factor, η, in heterogeneous systems. The method utilizes the collision probability approach to provide a coupled set of equations more transparent physically than the straightforward but unwieldy techniques used in solving the thermal space-energy problem. The first portion of the work makes use of full scattering matrix representations of the scattering law to provide estimates of the errors in both the spectra and integral parameters due only to the spatial approximations in the collision probability approach. Errors in the spectra and integral parameters are evaluated by comparison with the results determined by using a 32 thermal group, high order transport computer calculation. The effect of assuming in-group scattering only in the fuel region on the thermal utilization factor and the spectrum was also evaluated. The flat flux approximation employed in the collision probability method was investigated to determine the extent of the errors in the collision probability due to the use of this approximation. The rational approximation, as applied to lattices, was also used to obtain collision probabilities and the errors in the spectra and integral parameters associated with its use were evaluated. An approximation in the integral equation—collision probability approach is made which involves the use of an extremely simple expression for the scattering law. The approximation leads to a Maxwellian-like term and a complementary function, T(E), for representing the scattering-in integral. The T(E) function depletes the low energy end of the Maxwellian and provides a mechanism for properly joining the 1/E tail in the limit of high energies. This modified collision probability method, the M-T method, is described in detail along with several tests of its adequacy in determining neutron energy spectra and values of η, f and disadvantage factors for a series of BNL metal slab experiments. Results of the M-T method for these quantities are compared with results obtained from experiment and from "exact" analytical methods. The generalization of the M-T model to consider higher terms of a degenerate kernel representation of the scattering kernel is shown to converge η and f slowly beyond the first term. The results obtained for the thermal utilization factor and thermal reproduction factor over large ranges of lattice parameters using the one term expansion are accurate to better than 1.0 percent. Additional evaluations of the M-T method were performed for hypothetical low enrichment uranium-water and uranium-plutonium-water lattices in which the detailed energy dependent spectra and integral parameters obtained with the method were compared with the results obtained from multigroup, high order transport calculations. It is shown that the M-T equations naturally reduce to a set which are analogous to the equations developed by Chernick in his treatment of resonance absorption. This implies the possibility of deriving a unified treatment of resonance and thermal absorption reaction rates. (Disser. Abstr.)

29856 (STI/PUB-160(Vol.1)) NEUTRON THERMALIZATION AND REACTOR SPECTRA. VOL. I. Proceedings Series. Proceedings of the Symposium held at Ann Arbor, Michigan, 17–21 July 1967. (International Atomic Energy Agency, Vienna (Austria)). 1968. 666p. (CONF-670707-(Vol.1)). IAEA: $13.50; Austrian Schillings 349.-; Pound 4.15.4; F Fr 66,20; DM 54,-.

Separate abstracts were prepared for 31 of the 44 papers included. The other 13 papers have previously appeared in NSA and may be located by referring to CONF-670707 in the report number index. (D.C.W.)

For abstracts of individual papers see: 29857–29871, 30320, 30321, and 30370–30383.

29857 NEUTRON WAVE PROPAGATION WITH A ONE-TERM DEGENERATE THERMALIZATION KERNEL. Kaper, H. G.; Ferziger, J. H.; Loyalka, S. K. (Stanford Univ., Calif.). pp 95-111 of Neutron Thermalization and Reactor Spectra. Vol. I. Vienna, International Atomic Energy Agency, 1968.

From IAEA Symposium on Neutron Thermalization and Reactor Spectra, Ann Arbor, Mich. See STI/PUB-160(Vol.1); CONF-670707-(Vol.1).

The propagation of thermal neutron waves in a semi-infinite medium is studied by means of the Boltzmann equation with an isotropic one-term degenerate thermalization kernel. A complete set of eigenfunctions of this equation is found; the spectrum consists of a two-dimensional continuum and, at low frequencies and small absorption, a pair of discrete points. The neutron density in a half-space induced by an oscillating source at the free surface is expanded in terms of the eigenfunctions. The expansion coefficients are determined from the boundary conditions via a method, introduced by Cercignani in the kinetic theory of gases, in which one solves a two-dimensional integral equation with the aid of the theory of generalized analytic functions. The results of numerical calculations of the phase-velocity and attenuation length are compared with experimental data. At low frequencies the behavior of the density is essentially that of the discrete term which decays at infinity. At higher frequencies the continuum terms become more important. Above the frequency at which the discrete modes disappear the neutron distribution remains wave-like but the phase-velocity and attenuation length are mildly position-dependent. The experimental implications of this are discussed. 12 references. (auth)

29858 INVARIANT EMBEDDING AND PROPAGATION OF NEUTRON WAVES IN A SEMI-INFINITE MEDIUM. Mockel, A. (Univ. of Florida, Gainesville). pp 113-23 of Neutron Thermalization and Reactor Spectra. Vol. I. Vienna, International Atomic Energy Agency, 1968.

From IAEA Symposium on Neutron Thermalization and Reactor Spectra, Ann Arbor, Mich. See STI/PUB-160(Vol.1); CONF-670707-(Vol.1).

The experimental study of the propagation of neutron waves through a medium is of great interest in determining the characteristic of the medium and can often be applied in cases where the pulsed neutron experiments would be difficult or too long to perform. However, one of the main difficulties of the wave propagation method lies in the interpretation of the experimental results. The use of invariant embedding to compute the characteristics of the propagation allows one to overcome most of the difficulties involved in the theoretical prediction of numerical results. As a preliminary problem, the study of the propagation of neutron waves in a semi-infinite non-multiplying medium has been performed, using invariant embedding. A degenerate kernel is used as the scattering kernel. Like the Milne problem, the method asks for solving first the equations giving the albedo of the semi-infinite medium. However, in the case of wave propagation, it is the Fourier transform of the time-dependent albedo which is of interest. Writing this Fourier transform and solving the resulting set of integral equations, the asymptotic complex relaxation length can be easily found by solving an algebraic eigenvalue problem. It is easy to show that the complex relaxation length $k(\omega)$ also satisfied a system of integral equations. From these, the dispersion relation for the complex relaxation length was obtained. (auth)

29859 SOME METHODS OF SOLVING NEUTRON THERMALIZATION THEORY PROBLEMS. Maiorov, L. V.; Trukhanov, G. Ya. (Inst. of Atomic Energy, Moscow). pp 145-58 of Neutron Thermalization and Reactor Spectra. Vol. I. Vienna, International Atomic Energy Agency, 1968. (In Russian).

From IAEA Symposium on Neutron Thermalization and Reactor Spectra, Ann Arbor, Mich. See STI/PUB-160(Vol.1); CONF-670707-(Vol.1).

Small-group methods, i.e., a way (collision method) of deriving that part of the total neutron spectrum which can be calculated with good accuracy using a small number of groups, are discussed. As an example, an appropriate system of equations for the intersecting-group method is formulated. The quasi-diffusion method of solving kinetic equations is generalized for thermalization problems. The suitability of the method for thermalization problems is discussed. The influence of chemical bonds and kinetic effects on neutron thermalization in temperature gradient systems is explained. 10 references. (auth)

29860 POSSIBLE SOLUTIONS OF VARIOUS TRANSPORT PROBLEMS. Lebedev, V. I. (Inst. of Atomic Energy, Moscow). pp 159-68 of Neutron Thermalization and Reactor Spectra. Vol. I. Vienna, International Atomic Energy Agency, 1968. (In Russian).

From IAEA Symposium on Neutron Thermalization and Reactor Spectra, Ann Arbor, Mich. See STI/PUB-160(Vol.1); CONF-670707-(Vol.1).

Let $x = (x_1, \ldots, x_q)$, $R_q(x)$ be the q-dimensional space ($q \geq 2$), s be the unit vector, and Ω the surface of the unit sphere. The problem of solving transport equations with a degenerate scattering indicatrix is a multidimensional problem in $R_q x\Omega$; the nature of these problems calls for rapidly converging iterative methods which do not require all the information on the preceding step. A KP method is proposed: the idea consists in solving in R_q simplified problems of error determination using successive iterative steps of decreasing difficulty. Two operations are performed in the KP: the K-operation is a simple iteration in $R_q x\Omega$ and operation $P = \{P_1(n_1), \ldots, P_s(n_s)\}$ is for the error with $P_k(n_k)$ representing the solution in R_q of the ultimate problem for a differential equation of order $2n_k$. P-operations are found and the convergence of the following methods is studied: $KP_1(n)$, $KP_1(n)P_2(0)$, $K^2P_1(n)$, cyclic $KP_1(1)$ and $KP_1(0)$ etc. For $2\pi T$ periodic problems the convergence is estimated, P(KP) (KP price) and cheap algorithms are found, and the non-improvability is shown. Numerical calculations indicated that the KP method is very efficient. The Case results are generalized for the q-dimensional case: in $R_q x\Omega$ a system of solutions is found for a homogeneous single-velocity transport equation with constant coefficients and an isotropic scattering indicatrix $\Phi_{\nu\omega}(s) \exp(\pm[(x,\omega)/\nu])$. These are generalized functions with $\nu \in \{[-1,1], \pm\nu_0\}$ and $\omega \in \Omega$. Theorems are proved for the completeness of $\{\Phi_{\nu\omega}\}$ in $L_2(\Omega)$, for the partial orthogonality of $\{\Phi_{\nu\omega}\}$ and the possibility of representing $\phi \in L_2(\Omega)$ by $\{\Phi_{\nu\omega}\}$. For $q > 3$ the second component of ν can be missing. $2\pi T$ periodic solutions of non-homogeneous transport equations are found for cells of different dimensions. (auth)

29861 DECAY OF A THERMAL NEUTRON PULSE IN A FINITE COHERENT MODERATOR. Ardente, V.; Rossi, G. (EURATOM, Ispra, Italy). pp 169-82 of Neutron Thermalization and Reactor Spectra. Vol. I. Vienna, International Atomic Energy Agency, 1968.

From IAEA Symposium on Neutron Thermalization and Reactor Spectra, Ann Arbor, Mich. See STI/PUB-160(Vol.1); CONF-670707-(Vol.1).

To investigate the problem of the approach to equilibrium of a fast neutron pulse in a finite crystalline medium, a phenomenological description of the decay process was worked out, based on the concept of the energy-dependent neutron mean life. The time evolution of the neutron flux can be represented for $t > \bar{t}$ ($\bar{t}$ is connected with the time at which the thermal pulse is fully built up) by means of the ansatz $\varphi(E,t) = f(E) \exp[-\lambda(E)t]$. The same time moments of order 0 and 1 as in the rigorous solution of the time-dependent Boltzmann equation are imposed on this flux. The functions $f(E)$ and $\lambda(E)$ are thus obtained, and from these the time evolution of the instantaneous slope of the so-called decay curve for the neutron population in the assembly considered (effective decay constant) is evaluated. The time moments are solutions of stationary Boltzmann equations, and for this reason these functions can be determined by means of a suitable calculational method for stationary neutron spectrum problems. This approach was used to analyse the decay process of a neutron pulse in coherent solid moderators, such as beryllium and graphite. For each of these moderators blocks of various dimensions were considered, on which pulsed neutron measurements were performed. The time moments $m_0(E)$ and $m_1(E)$ were determined by means of the code GATHER in the framework of the $D(E)B^2\varphi(E,t)$ approximation for the leakage term of the Boltzmann equation. The 101-group energy scheme of GATHER was adapted to the particular problem, which requires a very detailed analysis at very low energies (down to 0.5×10^{-4} eV). For the scattering kernel the incoherent approximation was used, as given by the phonon expansion in the form contained in the SUMMIT code. Interference effects were taken into account by evaluating the elastic (zero-phonon) term of the polycrystalline coherent scattering cross section for a hexagonal lattice. To analyze the sensitivity to the details of the moderator dynamics of such integral quantities as the total neutron density and the effective decay constant, as a function of time, the same calculations were made as for the case with the free-gas scattering matrix. This approach succeeds in predicting the experimental time evolution of the total neutron density for the cases in which a comparison has been possible. More generally it allows a deeper analysis of the moderator dynamics effects on the approach to equilibrium of the neutron pulse. (auth)

29862 QUASI-CLASSICAL APPROXIMATION FOR SCATTERING FROM MOLECULES. Summerfield, G. C.; Zweifel, P. F. (Univ. of Michigan, Ann Arbor). pp 283-91 of Neutron Thermalization and Reactor Spectra. Vol. I. Vienna, International Atomic Energy Agency, 1968.

From IAEA Symposium on Neutron Thermalization and Reactor

Spectra, Ann Arbor, Mich. See STI/PUB-160(Vol.1); CONF-670707-(Vol.1).

In a previous paper, an expression for the scattering cross section from a molecular substance was derived. This expression is based upon the so-called quasi-classical approximation. The scattering law is expressed in the form $S(\underline{K},\omega) \sim \int dt e^{-i\omega t} < \exp \{f(\underline{K},t)\} > T$. It is further shown that if $f(\underline{K},t)$ is expanded in a power series in t, and only linear terms retained, the Krieger-Nelkin result is obtained. Such an expansion is inconsistent, however, because the thermal average in the above equation introduces some terms quadratic in the time but other quadratic terms have been ignored when $f(\underline{K},t)$ was expanded. In the present work, the quantity $< \exp \{f(\underline{K},t)\} > T$ is expanded in a similar series, but retain all terms of order t^2. A closed form expression is then obtained for the incoherent portion of the cross-section, and comparisons are made with the Kreiger-Nelkin result and with some exact computer studies of molecular cross sections. Also, an expression that is highly accurate for smaller values of the momentum transfer, where the approximations described above are not particularly good, is derived. (auth)

29863 TEMPERATURE EFFECT ON NEUTRON SCATTERING KERNELS. Finkelstein, L. (Israel Atomic Energy Commission, Soreq). pp 323-32 of Neutron Thermalization and Reactor Spectra. Vol. I. Vienna, International Atomic Energy Agency, 1968.

From IAEA Symposium on Neutron Thermalization and Reactor Spectra, Ann Arbor, Mich. See STI/PUB-160(Vol.1); CONF-670707-(Vol.1).

An explicit form of the neutron scattering kernel is derived for the case of resonant cross section, elastic or inelastic scattering, and nuclear thermal motion. The expression obtained is a one-dimensional integral over the variable cross section, and it is shown to be useful in analyzing various situations of practical interest, when used in conjunction with tables of Laplace transforms. In particular, when the cross section is expanded in Laguerre polynomials, the integral can be evaluated analytically. (auth)

29864 INELASTIC NEUTRON SCATTERING IN METAL HYDRIDES, UC AND UO_2, AND APPLICATIONS OF THE SCATTERING LAW. Purohit, S. N. (Rensselaer Polytechnic Inst., Troy, N. Y.); Pan, S. S.; Bischoff, F.; Bryant, W. A.; Lajeunesse, C.; Yeater, M. L.; Moore, W. E.; Kirouac, G. J.; Esch, L. J.; Francis, N. C. pp 407-35 of Neutron Thermalization and Reactor Spectra. Vol. I. Vienna, International Atomic Energy Agency, 1968.

From IAEA Symposium on Neutron Thermalization and Reactor Spectra, Ann Arbor, Mich. See STI/PUB-160(Vol.1); CONF-670707-(Vol.1).

The measurements of inelastic neutron scattering in metallic hydrides, UC, and UO_2; and the calculation of their scattering laws are described. Scattering law applications are discussed. Measurements based on the energy loss method are made at the Rensselaer Linear Accelerator Laboratory. Measurements on ZrH_x (with varying hydrogen concentration), NbH, and ThH_2 were made at room temperature. The ZrH_2 and NbH measurements were repeated at liquid nitrogen temperature. For ZrH_x, the variation of optical level width caused by changing sample temperature, momentum transfer and concentration of hydrogen atoms was studied. NbH data exhibit a doublet at 0.12 and 0.164 eV. This is believed to arise from splitting of the 1-0 transition in the optical band into transverse and longitudinal modes. For metal hydrides the Einstein model is found to be a poor representation of the frequency spectrum. Differential scattering cross sections were obtained for UC, using an 85%-transmission powder sample, 0.134-eV incident energy, and six scattering angles (14 to 150°). A peak at 0.045-eV excitation is observed. UO_2 data were obtained on a depleted powder sample having approximately 95% transmission, for incident energies of 0.341 eV and scattering angles of 25 to 150°. Evidence of inelastic scattering from excitations beyond 0.1 eV, the limit of previous measurements, is observed. Theoretical scattering laws were calculated for ZrH_2, UC, and UO_2. The UC scattering data were compared with theoretical results based on a Debye acoustic mode at 0.014 eV and a Gaussian distribution at 0.045 eV. Agreement between theory and experiment is good. For ZrH_2 and UO_2, the frequency spectra reported in the literature were employed. A treatment of proposed multiple scattering corrections is described. Applications of scattering laws are also discussed. The importance of the experimental and theoretical study of Placzek moments is stressed. The role of these moments, including the effective temperature, in the study of Doppler broadening of resonances of fissile, fertile, and structural materials is emphasized. This broadening may play a significant role in temperature coefficients of fast reactors. (auth)

29865 METHODS CURRENTLY USED TO COMPUTE SPATIALLY DEPENDENT THERMAL NEUTRON SPECTRA. A REVIEW. Honeck, H. C. (Atomic Energy Commission, Washington, D. C.). pp 521-36 of Neutron Thermalization and Reactor Spectra. Vol. I. Vienna, International Atomic Energy Agency, 1968.

From IAEA Symposium on Neutron Thermalization and Reactor Spectra, Ann Arbor, Mich. See STI/PUB-160(Vol.1); CONF-670707-(Vol.1).

A compilation of numeric and analytic methods used for calculations of spatially dependent thermal neutron spectra is given. An analysis of these methods is given. A list of references is broken down into the following categories: general references-4 references; computer codes-31 references; application of the codes-21 references; the Milne Problem-10 references; temperature discontinuities.-5 references; other references-10 references. (M.L.S.)

29866 INTEGRAL AND ANGULAR CHARACTERISTICS OF THERMAL NEUTRON LEAKAGE SPECTRA. Kallfelz, J. M. (Georgia Inst. of Tech., Atlanta); Kladnik, R. pp 555-69 of Neutron Thermalization and Reactor Spectra. Vol. I. Vienna, International Atomic Energy Agency, 1968.

From IAEA Symposium on Neutron Thermalization and Reactor Spectra, Ann Arbor, Mich. See STI/PUB-160(Vol.1); CONF-670707-(Vol.1).

The energy-dependent Milne problem for thermal neutrons has been investigated with increased experimental accuracy and more advanced theory in the past several years. Based on previously reported calculations and experiments of the authors and others, certain aspects of the Milne problem for a non-absorbing medium are sufficiently understood that semi-empirical expressions can be given for the dependence of various quantities. This paper gives the development of such expressions. Furthermore, a variational-iterative method used by the authors and others to solve the Milne problem is described briefly, and a further improvement to earlier solutions is given. Simple semi-empirical expressions are given for the average energy of the angular-dependent leakage spectra (energy distribution of neutrons leaking from the moderator surface into the vacuum) which depend on the value of the second energy-exchange moment (M_2) of the scattering kernel, and on the space-asymptotic solution. The change near the moderator surface in the average energy of the current can also be described by a simple expression involving M_2. Since the space-asymptotic solutions are easy to obtain numerically, this provides a simple method for calculating approximately the average energies of the leakage spectra and current. The validity of the semi-empirical expressions is supported by showing qualitatively through the transport equation that the dependence on M_2 is to be expected. Calculations were made for realistic scattering kernels for H_2O, benzene, Dowtherm A, and $ZrH_{1.7}$, as well as for the free gas and Corngold separable scattering kernels. Agreement with the experimental results available (primarily for H_2O) is good. (auth)

29867 EFFECT OF SCATTERING ANISOTROPY ON THE CALCULATION OF PULSED-NEUTRON DECAY CONSTANTS. Dorning, J. (Brookhaven National Lab., Upton, N. Y. Columbia Univ., New York). pp 571-89 of Neutron Thermalization and Reactor Spectra. Vol. I. Vienna, International Atomic Energy Agency, 1968.

From IAEA Symposium on Neutron Thermalization and Reactor Spectra, Ann Arbor, Mich. See STI/PUB-160(Vol.1); CONF-670707-(Vol.1).

The effect of including various orders of scattering anisotropy in the calculation of pulsed-neutron (die-away) experiment discrete time-decay constants is examined. The fundamental mode thermal neutron decay constants for spherical light-water systems are computed using realistic scattering models for the bound hydrogen atoms of the H_2O molecule. (Separate calculations were performed using the Nelkin model and the Young and Koppel model.) The results of extensive computations of decay constants for small systems using the discrete S_n method are presented. By the use of this method, the introduction of an $e^{i\vec{B}\cdot\vec{r}}$ Ansatz and the accompanying vagueness and difficulties in assigning extrapolation distances for small systems are avoided. Comparison with experiment shows that retention of the linearly anisotropic (P-1) term in the scattering kernel is essential and indeed considerably more important than model refinement. The inclusion of higher order scattering anisotropies (P-2, P-3), however, leads to extremely small changes in the computed decay constants. These results are physically very acceptable since the flux decay in small systems is dominated by leakage. As demonstrated by the calculations, the isotropic scattering approximation underestimates the leakage, whereas the P-1 approximation results in a rather accurate determination of this dominating factor. The use of

"transport-corrected" P-0 cross-sections results in surprisingly accurate values for the decay constants of systems in the experimental range, and the computations show that this simple efficient method of accounting for scattering anisotropy is adequate for decay constant calculations in H_2O. Additional information obtained from the calculations include the space-dependent energy spectra. The energy spectrum throughout a typical small system is significantly diffusion cooled, the spectrum at the center being softer than that at the surface. The spectra resulting from P-0 scattering calculations are not cooled quite as much as those obtained by transport-corrected P-0 and higher-order scattering computations which yield almost identical energy distributions for systems in the experimental range. The effects of completely neglecting chemical binding are shown to be significant by comparing decay constants resulting from calculations based on the proton gas model with those obtained for the more realistic anisotropic model. (auth)

29868 CALCULATIONS ON THE FUNDAMENTAL TIME-DECAY CONSTANT OF WATER AND POLYETHYLENE. Griffing, G. W. (Idaho Nuclear Corp., Idaho Falls). pp 643-53 of Neutron Thermalization and Reactor Spectra. Vol. I. Vienna, International Atomic Energy Agency, 1968.

From IAEA Symposium on Neutron Thermalization and Reactor Spectra, Ann Arbor, Mich. See STI/PUB-160(Vol.1); CONF-670707-(Vol.1).

The computed time-decay spectrum of the Nelkin, GIN, and MR scattering kernels for water are compared. The spectrum for the Nelkin and GIN kernels were found to be nearly the same. However, the two discrete higher time eigenvalues of the MR kernel, which is in closer agreement with the experimental data on the partial differential cross section, are more closely spaced and smaller in magnitude than the corresponding eigenvalues for the other two kernels. In addition, the limit of the discrete spectrum as given by $(\nu\Sigma_s)_{min}$ is approximately 0.22 μsec^{-1} for the MR kernel and 0.32 μsec^{-1} for the other scattering kernels. Deviations of less than one percent were found between the calculated and experimental results for the fundamental time-decay constant of water in spherical geometry. The experiments were done by Gon, who made measurements on various-sized systems with bucklings ranging from 0.09 to approximately 3.0 cm^{-2}. The magnitude of the computed fundamental time-decay constant was found not to be particularly sensitive to the kernel used. Comparisons of the calculated and experimentally observed fundamental time-decay constant for polyethylene in cylindrical geometry were also made. For bucklings less than 0.15 cm^{-2}, deviations of less than one percent were noted. For larger bucklings, deviations of approximately two percent were found, except for the largest buckling of approximately 1.5 cm^{-2} which deviated by six percent. The McMurry scattering kernel was used in the computations on polyethylene. (auth)

29869 NEUTRON SCATTERING FROM MOLECULAR NITROGEN. Young, J. A. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). pp 303-10 of Neutron Thermalization and Reactor Spectra. Vol. I. Vienna, International Atomic Energy Agency, 1968.

From IAEA Symposium on Neutron Thermalization and Reactor Spectra, Ann Arbor, Mich. See STI/PUB-160(Vol.1); CONF-670707-(Vol.1).

The scattering of slow neutrons by molecular nitrogen was calculated. The purpose of this calculation was to obtain a formulation which would allow relatively accurate results and which would be easy to evaluate numerically. The latter criterion rules out an exact calculation. The approach used takes into account all the rotational, vibrational, and translational motions of the N_2 molecules but ignores spin correlations. The procedure utilizes the mass-tensor or Krieger-Nelkin approximation for the rotational motions. The vibrations are included also, but neglect upscattering since the vibrational level at 0.3 eV is high compared with the thermal energy. The translational motion is included, assuming a free gas of N_2 molecules. Interference scattering between the two nitrogen atoms in a molecule was included for the sake of completeness. The scattering laws (α,β) were evaluated; and from the computer code FLANGE, the total cross section, angular cross sections, and slowing-down power were obtained for initial neutron energies ranging up to 1 eV. The total cross section agrees quite well with experiment. The angular cross section shows a fair degree of anisotropy but no experimental data are known for this cross section. (auth)

29870 AMPLITUDE OF THE TWO-QUANTUM TERM IN THE SCATTERING LAW FOR MOLECULAR GASES. Carpenter, J. M.; Schaefer, R. A. (Univ. of Michigan, Ann Arbor). pp 293-302 of Neutron Thermalization and Reactor Spectra. Vol. I. Vienna, International Atomic Energy Agency, 1968.

From IAEA Symposium on Neutron Thermalization and Reactor Spectra, Ann Arbor, Mich. See STI/PUB-160(Vol.1); CONF-670707-(Vol.1).

The orientation-averaged amplitude of the two-quantum term in the scattering law for coherent scattering of neutrons by molecular gases is computed in closed form. The phase factor $e^{i\kappa\cdot b}$ is averaged jointly with the amplitude factor $(\vec{\kappa}\cdot\vec{l}_1)(\vec{\kappa}\cdot\vec{l}_2)(\vec{\kappa}\cdot\vec{l}_3)(\vec{\kappa}\cdot\vec{l}_4)$. The resulting expression is appropriate for use in approximately calculating thermalization kernels, and for interpreting measurements of scattering laws for coherent molecular gases. Calculations are performed for C_2F_6, for the two-quantum combinations of the $\hbar\omega_{12}$ = 216 cm^{-1} = 27 MeV mode with the $\hbar\omega_3$ = 34.9 cm^{-1} = 43.5 MeV and the $\hbar\omega_9$ = 371 cm^{-1} = 46.5 MeV modes. Calculations are also performed for the two-quantum overtone of Br_2. The results of the calculations show that interference-scattering effects are significant in comparison with the direct scattering amplitude. The possibility is discussed of a method of "inelastic diffraction" by means of which maxima in measured scattering laws may be interpreted to assign the frequencies according to symmetry species. (auth)

29871 INELASTIC SCATTERING OF NEUTRONS FROM BENZENE AND WATER. Ross, D. K.; Szabo, F. P.; Sanalan, Y. (Univ. of Birmingham, Eng.). pp 477-91 of Neutron Thermalization and Reactor Spectra. Vol. I. Vienna, International Atomic Energy Agency, 1968.

From IAEA Symposium on Neutron Thermalization and Reactor Spectra, Ann Arbor, Mich. See STI/PUB-160(Vol.1); CONF-670707-(Vol.1).

From measurements with the Birmingham University cold neutron scattering apparatus, values have been obtained for the upscattering cross-sections of benzene and water. The apparatus has a resolution of 0.0015 eV, and the measurements are made at eight angles of between 20 and 90° to the beam direction. Measurements were made on benzene at room temperature and on water at room temperature and 234°C. Although it is intended to further improve the resolution and statistics of the results, these already show some interesting features. The data were reduced to the form $S(\alpha,\beta)$, and the extrapolation technique of Egelstaff was used to extract the spectral density function $\rho(\beta)$. From neutron measurements at higher incident energies and other data, the rest of the $\rho(\beta)$ curve can be constructed and hence the scattering law regenerated using the LEAP-ADDELT programme. The regenerated results were compared with the experimental ones and where necessary the process was iterated until a good fit was obtained. The resultant $\rho(\beta)$ provides a good basis for the calculation of the scattering matrix required for reactor calculations. Benzene, which was chosen because of its similarity to a number of organic moderators and the existence of a theoretical model for its vibrations and rotations, gave a $\rho(\beta)$ which agreed to some extent with that obtained by Glaser but with a peak at lower energy. The results for water are similar to those obtained at Chalk River but there is some evidence for an extra peak in the derived function. This is reasonable because the cold neutron technique yields rather better energy resolution in the low-energy region as compared with the multi-rotor system used at Chalk River. (auth)

29872 (STI/PUB-160(Vol.2)) NEUTRON THERMALIZATION AND REACTOR SPECTRA. VOL. II. Proceedings Series. Proceedings of the Symposium held at Ann Arbor, Michigan, 17–21 July 1967. (International Atomic Energy Agency, Vienna (Austria)). 1968. 538p. (CONF-670707(Vol.2)). IAEA: $11.00; Austrian Schillings 285.-; £ 3.17.8; F Fr 53,90; DM 44,-.

Separate abstracts were prepared for 24 of the 29 papers included. The other five papers have previously appeared in NSA and may be located by referring to CONF-670707 in the report number index and to abstract number 21: 41690. (D.C.W.)

For abstracts of individual papers see: 29873–29892, 30325, 30326, 30329, and 30336.

29873 PROBLEMS AND PRECAUTIONS IN SPECTRAL-INDEX MEASUREMENTS. Stanford, G. S. (Argonne National Lab., Ill.). pp 37-47 of Neutron Thermalization and Reactor Spectra. Vol. II. Vienna, International Atomic Energy Agency, 1968.

From IAEA Symposium on Neutron Thermalization and Reactor Spectra, Ann Arbor, Mich. See STI/PUB-160(Vol.2); CONF-670707-(Vol.2).

Methods for making and interpreting spectral-index measurements are reviewed with emphasis on the activation method. It is proposed that standardized packets of foils be irradiated in a series of accurately known neutron spectra with subsequent counting under standardized conditions to develop a catalog of spectra. 61 references. (D.C.W.)

29874 THERMAL NEUTRON DIFFUSION AND RETHERMALIZATION IN HYDROGENOUS MATERIALS. Goddard,

A. J. H.; Grant, P. J.; Johnson, P. W.; Tremeer, G. E. B. (Imperial Coll. of Science and Tech., London). pp 131-48 of Neutron Thermalization and Reactor Spectra. Vol. II. Vienna, International Atomic Energy Agency, 1968.

From IAEA Symposium on Neutron Thermalization and Reactor Spectra, Ann Arbor, Mich. See STI/PUB-160(Vol.2); CONF-670707-(Vol.2).

Using the thermal columns of a reactor as neutron sources two experiments have been performed, the aim of the first being to test the ability of models for the scattering of neutrons by hydrogen bound in water to predict thermal neutron diffusion lengths in solutions of 1/v and non-1/v absorbers. In the second experiment rethermalization in Santowax-R (terphenyl) near a temperature discontinuity has been studied. Diffusion length measurements in both pure water and boric acid solutions have been carried out at 22.3 and 65°C, and in solutions of cadmium and gadolinium at the lower temperature only. In each case measurements were made over a wide range of concentrations. All measured inverse diffusion lengths lie within the $(\Sigma_T)_{min}$ limit of Corngold with the exception of those from the two most strongly absorbing cadmium solutions. Representation of each set of results as a power series in absorber concentration has enabled the coefficients up to the spectral distortion term to be determined and it is shown that considerable diffusion heating occurs in gadolinium solutions in contrast to the slight diffusion cooling observed in cadmium solutions. In a theoretical analysis four scattering models for bound hydrogen were used. Diffusion lengths were calculated by solving the transport equation for the lowest space eigenvalue in the B_L approximation with L = 2, using the method described by Honeck. The differentially heated experiment combined cold water and hot Santowax-R in slab geometry. Fission rates of ^{235}U and ^{239}Pu were measured with fission chamber detectors as a function of position across the tanks containing the liquids. Two diameters of chamber, 0.6 cm and 0.3 cm, were used to identify finite detector size effects. The general features of the fission rate distributions in the water and Santowax are discussed. In view of current interest concerning the existence of a rethermalization length when the principal scattering is by bound protons, the form of the transient flux in the hot tank is examined in detail. For comparison with the experimental results the fission rates of ^{235}U and ^{239}Pu have been calculated using the Winfrith DSN transport theory code. Scattering by hydrogen in water has been calculated from the Haywood model and in Santowax from a model fitted to the phased chopper velocity selector measurements of Brugger. (auth)

29875 SPATIALLY DEPENDENT SPECTRA IN SOLUTIONS OF CADMIUM IN HEAVY WATER. Wydler, P. (Eidgenossisches Institut fuer Reaktorforschung, Wurenlingen, Switzerland). pp 149-60 of Neutron Thermalization and Reactor Spectra. Vol. II. Vienna, International Atomic Energy Agency, 1968.

From IAEA Symposium on Neutron Thermalization and Reactor Spectra, Ann Arbor, Mich. See STI/PUB-160(Vol.2); CONF-670707-(Vol.2).

To check different scattering models for heavy water, measurements of the spatial dependence of the steady-state neutron spectrum in solutions of cadmium were made. The spectra were measured in slab geometry at various distances from a plane source. Calculations based on S_n theory were made using the free-gas model, the Nelkin-Honeck model, and the Haywood scattering kernel. It was found that the Haywood kernel fitted the experimental data best. (auth)

29876 ANISOTROPY OF A NEUTRON SPECTRUM IN WATER NEAR AN ABSORBER. Ishmaev, S. N.; Liman, G. F.; Maiorov, L. V.; Sadikov, I. P.; Chernyshov, A. A.; Bryzgalov, V. I. (Inst. of Atomic Energy, Moscow). pp 193-207 of Neutron Thermalization and Reactor Spectra. Vol. II. Vienna, International Atomic Energy Agency, 1968. (In Russian).

From IAEA Symposium on Neutron Thermalization and Reactor Spectra, Ann Arbor, Mich. See STI/PUB-160(Vol.2); CONF-670707-(Vol.2).

Measurements of the space-energy-angle distribution of neutrons in water near a plane cadmium surface were carried out with an experimental device on a linear accelerator. The method of measuring stationary neutron spectra using a chopper which rotates in phase, with accelerator triggering, is described. The results of measurements of space dependence of the spectra of neutrons flying in two opposite directions – from the absorber ($\mu = +1$) and to the absorber ($\mu = -1$) – show that there is strong anisotropy of the neutron spectrum close to the absorbing surface. A numerical solution of the kinetic equation (using the Nelkin model for water) yields a value for the angular space-energy neutron distribution which is compared with the experimental data. An analysis is made of the way in which the results are affected by the model of moderator and the anisotropy of neutron scattering in water. (auth)

29877 NEUTRON SPECTRA IN A TWO-ZONE GRAPHITE-WATER SYSTEM. Abdullaev, Kh. Sh.; Bryzgalov, V. I.; Dikarev, V. S.; Liman, G. F.; Maiorov, L. V.; Mostovoi, V. I.; Taraban'ko, V. A. (Inst. of Atomic Energy, Moscow). pp 233-44 of Neutron Thermalization and Reactor Spectra. Vol. II. Vienna, International Atomic Energy Agency, 1968. (In Russian).

From IAEA Symposium on Neutron Thermalization and Reactor Spectra, Ann Arbor, Mich. See STI/PUB-160(Vol.2); CONF-670707-(Vol.2).

The space-energy distribution of thermal neutrons was measured in a two-zone system consisting of a graphite block, 100 × 100 × 59.5 cm, with an adjacent water cylinder of diameter 37 cm. The system studied was set up in the WWR-2 reactor bay close to the core, which served as external neutron source. To obtain the necessary temperature gradient between the zones, the graphite and water were separated by a thin layer of thermal insulation. Measurements were made at graphite temperatures of 133, 303, 359, and 443°K. At a graphite temperature of 133°K, the water temperature was kept at 297 or 343°K, and in the remaining cases the temperature of the water was 294 and 304°K. The low graphite temperature was obtained by cooling the graphite block with liquid nitrogen. The neutron spectra were measured at different distances from the graphite-water boundary using the time-of-flight method. The results of the measurements indicate that there is a pronounced increase in the neutron temperature relaxation length as the graphite temperature decreases. Experimental results are given, and the measured spectra are compared with calculated values obtained by solving the kinetic equation taking account of the anisotropy of neutron inelastic scattering in cold graphite. (auth)

29878 MEASUREMENTS ON THE THERMALIZATION PROCESS IN BERYLLIUM OXIDE USING SPECTRAL INDICATORS AND COMPARISON WITH THEORY. Maher, K. J. (Australian Atomic Energy Commission, Lucas Heights); Ritchie, A. I. M.; Rainbow, M. T. pp 245-56 of Neutron Thermalization and Reactor Spectra. Vol. II. Vienna, International Atomic Energy Agency, 1968.

From IAEA Symposium on Neutron Thermalization and Reactor Spectra, Ann Arbor, Mich. See STI/PUB-160(Vol.2); CONF-670707-(Vol.2).

The reaction rate of ^{239}Pu as a function of time and space in a large block of BeO following the injection of a burst of high-energy neutrons was measured. Fission counters provided the reaction rates and the block was a cube of side 60 cm using BeO of density 2.87 g/cm^3. The time range investigated was from immediately after, to 1 ms after the input pulse. The value 17.5 ± 3.0 μs found for the slowing-down time to the ^{239}Pu resonance is in good agreement with that of Zhezherun. The pulsed source was provided by a 3-MeV Van de Graaff accelerator with beam deflection in the top terminal backed up by post-acceleration deflection. The beam could be externally triggered to produce beam pulses ranging from 2 to 500 μs. A multigroup code is described which approximates the leakage by a DB^2 term and which solves the time dependence by a time-stepping technique. The time-dependent reaction rates for indium, cadmium, plutonium and samarium were calculated using the code, and the slowing-down times to those resonances were compared with experimental values. It is proposed to extend the present work to cover the range 0.1 to 1.0 eV. A brief description is given of a method of doing this using suitable (n,γ) resonances and a large sodium iodide crystal. (auth)

29879 TIME-DEPENDENT NEUTRON SPECTRUM IN ZIRCONIUM HYDRIDE. Manninen, J.; Tiihonen, J.; Jauho, P. (Technical Univ. of Helsinki, Otaniemi, Finland). pp 257-69 of Neutron Thermalization and Reactor Spectra. Vol. II. Vienna, International Atomic Energy Agency, 1968.

From IAEA Symposium on Neutron Thermalization and Reactor Spectra, Ann Arbor, Mich. See STI/PUB-160(Vol.2); CONF-670707-(Vol.2).

The time dependence of slowing-down and thermalization of neutrons emitted by a homogeneously distributed pulse source in an infinite ZrH moderator has been studied by numerical methods using various scattering models. The calculations have been performed using a method presented earlier by the authors, where the neutron density is expanded in a Taylor series in time for suitably chosen successive time values. A simple recursion formula is obtained for the coefficients of the series. The free atom scattering model is assumed for neutron energies > 1 eV. The scattering kernels used in the thermalization region are: a kernel computed from the Einstein one-frequency oscillator model which is highly singular, and two kernels generated at 39 suitably chosen energy points by the computer programme SUMMIT based on the distributed frequency spectrum model. The time dependence of the lowest spatial mode in a finite ZrH block has also been studied by essentially the same numerical method using the diffusion approx-

imation and the Einstein model. The calculations have been extended in time in the case of an infinite moderator into values which correspond in ZrH_2 to about 50 μs and in the finite case to over 150 μs. The calculated spectra have been compared where possible with the few experimental results presented in literature. The scattering models used seem to be able to describe, at least qualitatively, the unusual features of thermalization in ZrH. The quantitative agreement is not, however, too good between the calculated and experimental results. Possible explanations for this are presented in this paper and the validity of the models is discussed. (auth)

29880 X-Y DEPENDENT THERMAL NEUTRON SPECTRA IN WATER NEAR PROBE TUBES AND IN OTHER SMALL RECTANGULAR GEOMETRIES. Caspers, L. M.; Janssen, A. J. (Technological Univ., Delft, Netherlands). pp 271-84 of Neutron Thermalization and Reactor Spectra. Vol. II. Vienna, International Atomic Energy Agency, 1968.

From IAEA Symposium on Neutron Thermalization and Reactor Spectra, Ann Arbor, Mich. See STI/PUB-160(Vol.2); CONF-670707-(Vol.2).

Thermal neutron spectra measured with the time-of-flight method are perturbed by the presence of the probe tube. To minimize this effect, the cross section of the probe tube is often chosen as a rectangle with one side much smaller than the other. The introduction of such a probe tube in a one-dimensional system with slab geometry renders this system two-dimensional (x-y geometry); to evaluate the remaining probe-tube perturbation two-dimensional x-y transport theory may be used. A code PPIXY is described which calculates this remaining perturbation with integral transport theory using a two-dimensional x-y transport kernel. For this kernel an approximate analytic expression is given, as well as a more exact form which is generated by a numerical program. Calculated results obtained with PPIXY for water slabs and probe tubes of different sizes are given in one-group and ten-group approximation. To gain some confidence in the theory on which PPIXY is based, time-of-flight leakage spectra from, and $^{177}Lu-^{165}Dy$ activation ratios in a few systems with x-y geometries were measured. The results obtained agree quite well with those calculated with integral x-y transport theory. (auth)

29881 A REVIEW OF RESEARCH ON NONSTATIONARY NEUTRON THERMALIZATION. Kazarnovskii, M. V. (Lebedev Inst. of Physics, Moscow). pp 287-329 of Neutron Thermalization and Reactor Spectra. Vol. II. Vienna, International Atomic Energy Agency, 1968. (In Russian).

From IAEA Symposium on Neutron Thermalization and Reactor Spectra, Ann Arbor, Mich. See STI/PUB-160(Vol.2); CONF-670707-(Vol.2).

A review of theoretical and experimental research on the thermalization of neutrons from nonstationary sources in nonmultiplying systems is presented. The following questions are considered: the eigenfunctions of the neutron transfer equation; the behavior, as a function of time, of pulsed neutron distribution in the process of approximating asymptotic or quasi-asymptotic distributions; and a combined description of various experiments from the viewpoint of the dispersion law and the neutron transfer equation. (auth)

29882 THEORY OF DECREASING PULSED NEUTRON DENSITY IN FINITE MODERATING VOLUMES. Kazarnovskii, M. V.; Maiorov, L. V.; Yudkevich, M. S. (Inst. of Atomic Energy, Moscow). pp 331-44 of Neutron Thermalization and Reactor Spectra. Vol. II. Vienna, International Atomic Energy Agency, 1968. (In Russian).

From IAEA Symposium on Neutron Thermalization and Reactor Spectra, Ann Arbor, Mich. See STI/PUB-160(Vol.2); CONF-670707-(Vol.2).

A method of calculating neutron distribution as a function of time in finite media using a pulsed source was developed with which account can be taken of the trapping effect at low energies. Numerical calculations were carried out for actual moderators. The results obtained show that for relatively short times the neutron density decreases approximately exponentially, while for very long times in small systems a considerable deviation from the exponential law may be observed. (auth)

29883 PULSED SOURCE MEASUREMENTS ON NEUTRON THERMALIZATION IN GRAPHITE BY THE REACTION RATE TECHNIQUE. Hewitt, J. S.; Walker, J. (Univ. of Birmingham, Eng.). pp 347-62 of Neutron Thermalization and Reactor Spectra. Vol. II. Vienna, International Atomic Energy Agency, 1968.

From IAEA Symposium on Neutron Thermalization and Reactor Spectra, Ann Arbor, Mich. See STI/PUB-160(Vol.2); CONF-670707-(Vol.2).

The approach to thermal equilibrium of neutrons, produced by the $T(d,n)^4He$ reaction near the center of a 41 in. × 32 in. × 32 in. block of graphite, was studied by comparing as a function of time the rate of radiative capture events in small quantities of cadmium and mercury placed at various points in the medium. The main difficulty encountered has been the detection of the capture gamma rays originating in small (low perturbing) quantities of indicator under conditions of severe gamma background. The situation is complicated by the fact that the hydrogenous scintillators, which have been used in relatively large quantities in D_2O and H_2O experiments, would dominate the thermalization process if they were introduced in the graphite experiment, while certain efficient scintillators with weaker moderating properties must be excluded owing to activation. In the present experiment a 0.3-cm^3 anthracene scintillator was used to detect the gamma rays emitted from an adjacent 2 in. × ½ in. diam. cylindrical pellet of graphite powder impregnated with the indicator material. The effective bias levels of both the main detector and a monitor were stabilized to better than 0.1% by a specially constructed stabilizing system so that the large background component could be accurately assessed by repeating all runs without indicator present. Although the relatively long neutron pulses (85 μs), necessitated by counting-rate considerations, obscured detailed information on slowing down, the peak in the reaction ratio corresponding to the arrival of the neutrons at the 0.18-eV cadmium resonance was resolved at about 100 μs. For subsequent times the curves of reaction ratio can be regarded as two exponentials which decay into the equilibrium ratio. The faster component has a time constant of about 100 μs while the slower component, which is excited to a lesser degree, has a constant in the order of 1000 μs. The results permit neither a precise evaluation of the complete curves nor the detection of variations between the curves obtained at different points in the medium, but the behaviour of the curves at times dominated by the slow component was found to agree well with reaction ratios calculated from time-dependent spectra reported by Barnard et al., and by Poole. When compared on the basis of neutron temperature the present results differ greatly from those obtained previously using filtered detectors and other spectrum indicators. (auth)

29884 PROPAGATION OF THERMAL NEUTRON WAVES IN HEAVY WATER. Perez, R. B. (Univ. of Florida, Gainesville); Ohanian, M. J.; Dunlap, J. H. pp 363-78 of Neutron Thermalization and Reactor Spectra. Vol. II. Vienna, International Atomic Energy Agency, 1968.

From IAEA Symposium on Neutron Thermalization and Reactor Spectra, Ann Arbor, Mich. See STI/PUB-160(Vol.2); CONF-670707-(Vol.2).

Thermal neutron pulses of total widths ranging from 8 to 13 ms were injected into a heavy-water medium of dimensions 47.87 in. × 47.87 in. × 50.5 in. The thermal neutron bursts were generated by slowing down the 14-MeV neutrons from a D-T reaction in a thermalizing tank. The dispersive properties of the heavy water were very apparent through the smearing of the initial pulse. The velocity of propagation of the pulses was 177 m/s or only about 8% of the neutron speed at room temperature. Axial and transverse measurements were made. The analysis of the neutron pulses at the various locations into its wave components was performed by a numerical Fourier transformation. It was found that beyond about 30 cm from the source a plane wave was established. For a given detector location, the amplitude of the neutron wave decayed about three decades within the frequency range of 0 and 300 c/s. From both amplitude and phase shift plots, the dispersion law for heavy water was obtained. For the interpretation of the data, a theoretical model based on the diffusion approximation to the energy-dependent Boltzmann equation was used. Following this model, the squared complex inverse relaxation length can be obtained in the form of a power series in frequency. The experimental dispersion law was fitted in accordance with this model. The diffusion coefficient was $2.00 \pm 0.05 \times 10^5$ cm^2/s, and the diffusion cooling coefficient was $3.8 \pm 0.9 \times 10^5$ cm^4/s. The error in the diffusion cooling coefficient reflects the scatter of results obtained by the various fitting techniques used in its determination. No attempt was made to obtain F_3 in view of the scatter of data in the high frequency region of the dispersion law. (auth)

29885 MEASUREMENT OF NEUTRON PULSE DECAY IN SMALL BLOCKS OF Be AND BeO. Zhezherun, I. F. (Inst. of Atomic Energy, Moscow). pp 379-93 of Neutron Thermalization and Reactor Spectra. Vol. II. Vienna, International Atomic Energy Agency, 1968. (In Russian).

From IAEA Symposium on Neutron Thermalization and Reactor Spectra, Ann Arbor, Mich. See STI/PUB-160(Vol.2); CONF-670707-(Vol.2).

In recent years many theoretical works have appeared on the spectrum of λ-eigenvalues for the Boltzmann equation describing the behaviour of neutrons in small crystalline moderator blocks excited by pulsed neutron sources. Corngold has shown that the discrete λ spectrum has a limit $\lambda \leq \lambda_{lim} \equiv (v\Sigma)_{min}$, where Σ =

$\Sigma_a + \Sigma_{sin}$. The value $(v\Sigma)$ has a minimum at $v \to 0$ and has been determined for many moderators. Above λ_{lim} there is only a continuous spectrum. It is therefore not possible, with a single exponential, to describe the neutron density decay in small moderator blocks with a geometrical buckling B^2 greater than B^2_{lim} which corresponds to λ_{lim}. Experiments using a linear electron accelerator in order to obtain further accurate measurements of neutron density decay in small blocks of Be and BeO with geometrical buckling down to 0.1 cm^{-2} are described. In these experiments special attention was given to the effect of changes in the experimental conditions (background, different block shielding, etc.) on the measuring results. Due to the intensity of the neutron source and the types of detector used, it was possible to measure the neutron density decay over four decades in the time interval 0 to 1.5 to 2 ms starting from the moment of the neutron pulse. The λ decay constants were determined from the neutron density measurements using a least-squares method and an electronic computer and adopting the procedure of successively omitting previous points to deal with the harmonics which arise. Exponential decay was observed for λ much greater than λ_{lim}, but above the physical limit λ_k: $\lambda_k = (v\Sigma + \frac{1}{3} v\lambda_{tr}(v)B^2)_{min}$, $v = v_0 \pm 0$, proposed by Kothari et al., there is a slight deviation from the exponential. On the basis of the experimental data an analysis is given of the way in which the value of the diffusion and diffusion-cooling coefficients D and S are affected by the use of the measured values $\lambda \geq \lambda_{lim}$. (auth)

29886 PULSED NEUTRON MEASUREMENTS IN WATER. Paiano, M. C.; Paiano, S. (Inst. of Atomic Energy, Sao Paulo, Brazil). pp 395-410 of Neutron Thermalization and Reactor Spectra. Vol. II. Vienna, International Atomic Energy Agency, 1968.

From IAEA Symposium on Neutron Thermalization and Reactor Spectra, Ann Arbor, Mich. See STI/PUB-160(Vol.2); CONF-670707-(Vol.2).

The results of recent measurements of the thermal neutron diffusion parameters of water using the pulsed neutron technique are presented. All measurements were done in cubic geometries with bucklings varying from 0.037 to 0.785 cm^{-2}. The effect of the aluminum walls of the containers was estimated in terms of an equivalent water thickness. The method used to correct the counting losses of the detector and counting system is presented. The decay curves were analyzed by a least-squares method and care was taken of the influence, on the diffusion parameters, of various values for the extrapolation distance and of different weighting factors for the experimental points of the λ versus B^2 curve fitting. The results indicate that the weighting factors may have a considerable influence on the values of the diffusion constant and diffusion cooling coefficient. Furthermore, the comparison of these experimental results with the results obtained in experiments using flat and cubic geometries indicates that the shape effect on the diffusion parameters can be less important than has been considered. (auth)

29887 THERMALIZATION OF NEUTRONS IN ZIRCONIUM HYDRIDE AND ICE. Reichardt, W. (Kernforschungszentrum, Karlsruhe, Ger.). pp 411-37 of Neutron Thermalization and Reactor Spectra. Vol. II. Vienna, International Atomic Energy Agency, 1968.

From IAEA Symposium on Neutron Thermalization and Reactor Spectra, Ann Arbor, Mich. See STI/PUB-160(Vol.2); CONF-670707-(Vol.2).

Time-dependent neutron spectra were investigated by the combined pulsed source-chopper technique in zirconium hydride and ordinary ice of 21°K. It was found that in zirconium hydride at room temperature the asymptotic equilibrium distribution was established about 450 μs after the injection of the fast neutron pulse. In ice of 21°K the asymptotic state could not be verified experimentally. Even 750 μs after the pulse of the source the average energy of the spectra was about 30% higher than that of a Maxwellian of 21°K. The results of the measurements are compared with calculations made with a computer code SPIZI which calculates time-dependent neutron spectra in the diffusion approximation. The scattering kernels are obtained from generalized frequency distributions using the codes LEAP, ADDELT and KAPIXSE. With these scattering kernels, diffusion parameters as obtained by lifetime measurements are calculated and are compared with the experimental data. (auth)

29888 STUDY OF TIME-DEPENDENT NEUTRON THERMALIZATION IN WATER. Ishmaev, S. N.; Mostovoi, B. I.; Sadikov, I. P.; Tolmacheva, L. A.; Chernyshov, A. A. (Inst. of Atomic Energy, Moscow). pp 439-47 of Neutron Thermalization and Reactor Spectra. Vol. II. Vienna, International Atomic Energy Agency, 1968. (In Russian).

From IAEA Symposium on Neutron Thermalization and Reactor Spectra, Ann Arbor, Mich. See STI/PUB-160(Vol.2); CONF-670707-(Vol.2).

The results of some preliminary experiments performed in studying the time-dependent thermalization of neutrons in water differed considerably from the theoretical values. A procedure for measuring and processing the results has therefore been specially developed, and new studies have been undertaken on the establishment of a time-dependent neutron equilibrium spectrum in a large aqueous system near an almost point source of fast pulsed neutrons. The effect of neutron diffusion during thermalization on the total time necessary to establish the equilibrium spectrum at various distances from the source was studied. (auth)

29889 MEASUREMENT OF DIFFUSION PARAMETERS IN A GRAPHITE BLOCK WITH CHANNELS USING THE PULSED METHOD. Zhezherun, I. F. (Inst. of Atomic Energy, Moscow). pp 449-60 of Neutron Thermalization and Reactor Spectra. Vol. II. Vienna, International Atomic Energy Agency, 1968. (In Russian).

From IAEA Symposium on Neutron Thermalization and Reactor Spectra, Ann Arbor, Mich. See STI/PUB-160(Vol.2); CONF-670707-(Vol.2).

Experiments on neutron diffusion in a graphite medium consisting of a square lattice of cylindrical channels of 0.8-cm radius and 2.0-cm pitch (space-solid volume ratio = 1.01), and in solid graphite, the channels being filled with graphite rods. The λ decay constant was measured for graphite blocks of different dimensions in the shape of a rectangular parallelepiped. The following three sets of measurements were performed: in solid graphite blocks; in blocks with channels, the blocks having different dimensions along the channels; and in blocks with channels, the blocks having different dimensions transversely to the channels. The λ decay constant was calculated from measurements of neutron density decay as a function of time using a least-squares method and an electronic computer and adopting the familiar procedure of omitting previous points to deal with the fundamental harmonic. By analyzing the dependence of λ on the buckling B^2 for solid graphite and on the longitudinal and transversal buckling, B^2_l and B^2_t, for graphite with channels, it was possible to obtain the diffusion and diffusion cooling coefficients for these media and the relation between them. (auth)

29890 DETERMINATION OF THERMALIZATION PARAMETERS IN GRAPHITE. Sumita, K.; Takahashi, A. (Osaka Univ.). pp 461-78 of Neutron Thermalization and Reactor Spectra. Vol. II. Vienna, International Atomic Energy Agency, 1968.

From IAEA Symposium on Neutron Thermalization and Reactor Spectra, Ann Arbor, Mich. See STI/PUB-160(Vol.2); CONF-670707-(Vol.2).

In part one, measurements of the 14-MeV neutron slowing-down times of graphite by the resonance filter method are presented. The distributions of the slowing-down time at a few energy points near the thermal equilibrium were obtained as the difference of the time responses of the compensation filter-covered BF_3 counter and the resonance absorber-covered counter. The most probable slowing-down times, t_{max}, are 9.5 ± 0.5 μs for 5.2 eV, 10.5 ± 0.5 μs for 4.91 eV, 20 ± 1 μs for 1.46 eV, 55 ± 4 μs for 0.28 eV, 71 ± 4 μs for 0.2 eV, and 101 ± 8 μs for 0.11 eV. The values over 1.46 eV show good agreement with the values obtained by the 0°K free-gas model. The values under 0.28 eV agree with the values from the Williams' model with the Parks' kernel. The effects of finite medium and space dependence are also investigated. In part two, the thermalization parameter measurement by the pulse propagation method is presented. A thermal pulse source is constructed, based on the distinct difference in the slowing-down and the thermalization times between paraffin and graphite. The peaks and the valleys are observed in the gain and the phase lag curves at various distances from the source over about 2000 rad/s, which is determined by the existence of the continuum eigenvalue region due to the cold neutron penetration in the frequency-dependent inverse attenuation length. The diffusion coefficient and the diffusion cooling coefficient are obtained under this frequency. The results (obtained up to 20°C, density 1.6 g/cm^3) are the following: $D_0 = 2.16 \pm 0.02 \times 10^5$ cm^2/s, $C_0 = 2.8 \pm 0.3 \times 10^8$ cm^4/s. The results by the die-away experiment using the same graphite under the critical buckling are the following: $D_0 = 2.21 \pm 0.08 \times 10^5$ cm^2/s, $C_0 = 2.6 \pm 1.2 \times 10^8$ cm^4/s. (auth)

29891 DETERMINATION OF THE THERMALIZATION TIME IN GRAPHITE BY THE FREQUENCY CHARACTERISTIC METHOD. Purica, I.; Seferian, N.; Racataianu, I.; Giuclea, I.; Marcu, G. (Inst. of Atomic Physics, Bucharest). pp 479-502 of Neutron Thermalization and Reactor Spectra. Vol. II. Vienna, International Atomic Energy Agency, 1968.

From IAEA Symposium on Neutron Thermalization and Reactor

Spectra, Ann Arbor, Mich. See STI/PUB-160(Vol.2); CONF-670707-(Vol.2).

In the frequency characteristic method, the amplitude A and phase α of the neutron flux oscillations $\Phi(r,t)$, induced by a sinusoidally modulated source in a medium of buckling B^2, were measured for different buckling values. A^2 as a function of the square of angular frequency is a sum of hyperbolas $\gamma_{jk}/(\omega^2 + \lambda_{jk}^2)$, each one corresponding to a spatial harmonic k, and to an energy harmonic j, if the spectrum is expanded in a system of bi-orthonormal first-order Laguerre polynomials. This means that the continuum eigenvalues spectrum is approximated by a number of pseudo-discrete eigenvalues. A quantitative look shows that γ_{10} and γ_{01} are of opposite signs. An experimental check, in which the influence of the spatial harmonic is modified by changing the detector-source's relative position, corroborates this fact. It is therefore possible to separate the influence of the continuum eigenvalues spectrum approximated by $\lambda_{10}(B^2)$. Its reciprocal is the thermalization time $\tau_{th} = 1/[\lambda_{10}(0) - \langle v\Sigma_a \rangle]$. Eighteen graphite prisms were used, covering a B^2 range of 14 to 12×10^{-3} cm^{-2}. The frequency range explored was f = 0 to 1000 Hz. The frequencies were measured with an error of 0.2%; their constancy during the measurement was 0.3%. The value 694 ± 57 μs was obtained for the thermalization time. This is in good agreement with that obtained by Serdula, but differs from the values obtained by Kaneko and Sumita, and by Beckurts, all measured by the pulsed source method. The one pseudo-discrete eigenvalue approximation of the continuum eigenvalues spectrum for the graphite gives results comparable with those obtained by other methods, but is not sufficient for the interpretation of our experiment. (auth)

29892 TIME-DEPENDENT NEUTRON SPECTRUM MEASUREMENTS IN LEAD IN THE EPITHERMAL ENERGY REGION. Navalkar, M. P.; Chandramoleshwar, K.; Ramakrishna, D. V. S. (Bhabha Atomic Research Centre, Bombay). pp 503-9 of Neutron Thermalization and Reactor Spectra. Vol. II. Vienna, International Atomic Energy Agency, 1968.

From IAEA Symposium on Neutron Thermalization and Reactor Spectra, Ann Arbor, Mich. See STI/PUB-160(Vol.2); CONF-670707-(Vol.2).

The time-dependent neutron spectrum in the energy region 1 to 5 eV where thermal motion influences the slowing-down process in lead was studied using a 400-keV pulsed Van de Graaff accelerator and multichannel time analyzer. Time-dependent capture gamma intensities for isolated resonances of Ag, Au, Ta, Ho, In, and Rh were measured as a function of slowing-down time in lead and were analyzed in terms of neutron dispersion using time moments which incorporate effects from the thermal motion of moderator nuclei. The effects of finite burst and channel widths, Doppler broadening of resonances, isotropic neutron distribution, admixture of oxygen introduced as a result of casting, etc. were taken into account in the analysis. The experimental results confirm that in the energy region of investigation the neutron spectrum in lead can be described by a Gaussian distribution centered about a mean slowing-down time with an energy-dependent dispersion in contrast to the energy-independent dispersion for nuclei considered free and at rest. (auth)

29893 IMPROVEMENTS IN OR RELATING TO NEUTRON PULSE SOURCES. (to Institut fuer Plasmaphysik GmbH). British Patent 1,111,093. Apr. 24, 1968. Priority date Aug. 12, 1964, Germany.

A neutron source is described in which a laser pulse of relatively low energy is used to evaporate deuterium and/or tritium from a target and a subsequent laser pulse of higher energy is used to heat the deuterium and/or tritium to temperatures that permit fusion reactions to occur. A neutron pulse with a duration of less than 10^{-9} sec and a neutron flux density of at least 10^{21} neutrons/cm^2/sec is available at the surface of the neutron source. (D.C.W.)

Nuclear Properties and Reactions, A≤ 5

Refer also to abstracts 28097, 28230, 29715, 29716, and 29907.

29894 (LA-3271) EVALUATED NEUTRON CROSS SECTIONS FOR DEUTERIUM. Horsley, Anthony; Stewart, Leona (Los Alamos Scientific Lab., N. Mex.). Nov. 1967. 139p. Dep. CFSTI.

A compilation of evaluated data on the neutron cross sections of deuterium is presented for incident neutron energies of 0.0001 eV to 20 MeV. The data are displayed in graphical and tabular form. Legendre coefficients are included for the scattering angular distributions. Proton spectra from neutron and proton reactions with deuterium are also included, as are proton production cross sections and neutron production cross sections. (D.C.W.)

29895 BINDING ENERGY OF HELIUM WITH A VELOCITY-DEPENDENT POTENTIAL. Jain, S. C. (Allahabad Univ., India); Srivastava, B. K. Phys. Rev., 169: 833-5(May 20, 1968).

A variational calculation of the binding energy of helium was made, using a two-body central velocity-dependent potential both in the ^1S and in the ^3S states. The two-parameter Irving wave function, and its suitable modifications with three and four parameters, were used as trial functions. The results show that the convergence is rather slow. Obviously the maximum binding energy is obtained for the four-parameter wave function. The maximum value obtained for the binding energy of helium is somewhat greater than the experimental value of 28.2 MeV, but is in reasonable agreement with similar calculations using hard-core potentials. (auth)

29896 DIFFERENTIAL CROSS SECTIONS AND POLARIZATIONS IN ELASTIC p-d SCATTERING AT MEDIUM ENERGIES. Bunker, S. N.; Cameron, J. M.; Carlson, R. F.; Richardson, J. Reginald; Tomas, P.; Van Oers, W. T. H.; Verba, J. W. (Univ. of California, Los Angeles). Contract AT(11-1)-GEN-10. Nucl. Phys., A113: 461-80(1968).

Differential cross sections for p-d elastic scattering have been measured at 22.0, 35.0, and 46.3 MeV using the energy-analyzed external proton beam of the UCLA sector-focused cyclotron. The angular distributions cover center-of-mass angles between 9 and 168°. At forward angles both protons and deuterons were observed using a dE/dx-E telescope counter consisting of a fully depleted surface-barrier (ΔE) and a NaI(Tl) scintillation detector (E). At larger angles, protons were observed using an array of four NaI(Tl) scintillation detectors. The differential cross sections have in general a relative uncertainty less than 2%, while the absolute scale of the measurements has an uncertainty of 1.7%. The proton polarization angular distributions at 35.0 and 40.0 MeV were also measured. In this part of the experiment, the polarized proton beam facility was used. The polarized proton beam was obtained by scattering the internal beam of the cyclotron from a carbon scatterer. At 35.0 MeV, the polarization angular distribution covers center-of-mass angles between 20 and 164°. At 40.0 MeV, measurements were made for center-of-mass angles greater than 130° only. Scattered particles were observed using six NaI(Tl) scintillation detectors placed in groups of three on either side of the incident beam. The target used when detecting elastically scattered protons was deuterium gas. The backward part of the angular distribution was measured by detecting recoil deuterons from a deuterated polyethylene target. The available proton polarization data for p-d elastic scattering have been used to construct a polarization contour diagram for the energy range 10 to 400 MeV. (auth)

29897 ELASTIC SCATTERING OF 600-MeV PROTONS BY ^{4}He. Boschitz, E. T. (Lewis Research Center, Cleveland); Roberts, W. K.; Vincent, J. S.; Gotow, K.; Gugelot, P. C.; Perdrisat, C. F.; Swenson, L. W. Phys. Rev. Lett., 20: 1116-19 (May 13, 1968.

The differential cross section for elastic scattering of 600-MeV protons from ^{4}He was measured for laboratory angles between 4 and 44°. The data are analyzed in terms of the diffraction approximation of Glauber. (auth)

29898 ELASTIC AND ALMOST ELASTIC SCATTERING OF HIGH-ENERGY PROTONS FROM DEUTERIUM. Czyz, W.; Lesniak, L. (Inst. of Nuclear Physics, Krakow). Bull. Acad. Pol. Sci., Ser. Sci. Math. Astron. Phys., 16: 137-40(1968).

The contribution of deuteron breakup to the p-d cross section at high energies is calculated. The results are in agreement with the experimental observation (Phys. Rev. Lett., 19: 389(1967)) of the lack of a minimum in the p-d elastic cross section predicted in all the Glauber-model type of calculations of the high-energy p-d cross section. (D.C.W.)

29899 ^{3}He(^{3}He,t)3p REACTION AT 44 MeV. Tombrello, T. A. (California Inst. of Tech., Pasadena); Slobodrian, R. J. Nucl. Phys., A111: 236-40(1968).

Triton spectra from the reaction ^{3}He(^{3}He, t)3p were measured at a bombarding energy of 44 MeV for lab angles between 6° and 25°. These spectra are quite featureless and show no indication of either a 3p final-state interaction or of a strong sequential decay mode. (auth)

29900 LIFETIMES OF THE FIRST EXCITED STATES IN ^{21}Ne AND ^{21}Na. Bamberger, A.; Lieb, K. P.; Povh, B.; Schwalm, D. (Univ., Heidelberg. Max-Planck-Institut fuer Kernphysik, Heidelberg). Nucl. Phys., A111: 12-16(1968).

The lifetimes of the $J^\pi = 5/2^+$ mirror states at $E_x = 350.5 \pm 1.0$

keV and 332 ± 1 keV in ^{21}Ne and ^{21}Na, respectively, were measured with the recoil-distance method. The two nuclei were produced by ^{20}Ne bombardment of a ^{2}H gas target. The results are τ = 22 ± 3 ps and 14 ± 3 ps for the states in ^{21}Ne and ^{21}Na, respectively. The measured lifetimes compare well with those calculated in the strong-coupling model taking into account band mixing. (auth)

29901 PROTON–PROTON FINAL-STATE INTERACTIONS IN THE REACTIONS ^{3}He(d,t)2p, d(^{3}He,t)2p, p(^{3}He,d)2p, AND ^{3}He(^{3}He,^{4}He)2p. Morton, B. J.; Gross, E. E.; Hungerford, E. V.; Malanify, J. J.; Zucker, A. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. Phys. Rev., 169: 825-32(May 20, 1968). (ORNL-P-3621).

The energy spectra of tritons, α particles, and deuterons from the reactions ^{3}He(d,t)2p, d(^{3}He,t)2p, ^{3}He(^{3}He,^{4}He)2p, and p(^{3}He,d)2p were measured at forward angles 0° to 5°, using 36-MeV deuterons and 53-MeV ^{3}He from the Oak Ridge isochronous cyclotron. The reaction d(^{3}He,t)2p at 0° was also studied at 74 MeV. All spectra had peaks in the high-energy region which are attributed to the enhancement of the cross section due to the final-state interaction of the two protons. The final-state interaction theory of Watson and Migdal gives an adequate representation of the data for the reactions ^{3}He(d,t)2p and ^{3}He(^{3}He,^{4}He)2p for the known proton-proton interaction. For the other two reactions, d(^{3}He,t)2p and p(^{3}He,d)2p, the observed peaks are much narrower than the predictions of the Watson-Migdal theory. In the case of d(^{3}He,t)2p the narrower peak could be explained by assuming the primary reaction mechanism to be a charge-exchange process. A search for a three-proton enhancement in the reaction ^{3}He(^{3}He,t)3p was unsuccessful. (auth)

29902 THE PHOTODISINTEGRATION CROSS SECTION OF ^{4}He. Lim, T. K. (Univ., Adelaide, Australia). Nucl. Phys., A113: 376-84(1968).

The integrated cross section σ_{int} for the photodisintegration of helium (^{4}He) is calculated by applying the sum rules of Levinger and Bethe and using a two-parameter Irving wave function. The two-body interactions are assumed to be that obtained from our modification of the central velocity-dependent potential of Srivastava and the Rarita-Present potential. The results give considerably better agreement with the experimental results of Gorbunov and Spiridonov than do those of other authors and indicate that Serber and Biel force mixtures are more suitable forms of interaction. (auth)

29903 TWO-CHANNEL CALCULATION FOR ELASTIC ^{3}He–^{3}He SCATTERING. Suenkel, W.; Wildermuth, K. (Univ., Tuebingen, Ger.). Phys. Lett., 26B: 655-7(Apr. 29, 1968).

The elastic scattering of ^{3}He on ^{3}He is calculated including the α-diproton channel. A comparison with the calculations of Thompson and Tang, where only the elastic channel is taken into account, is made. (auth)

Nuclear Properties and Reactions, 6 ≤ A ≤ 19

Refer also to abstracts 28097, 29941, 30048, 30067, 30068, and 30105.

29904 (EUR-3903) MEASUREMENTS OF NEUTRON SCATTERING FROM ^{7}Li. Knitter, H.-H.; Coppola, M. (European Atomic Energy Community, Geel (Belgium). Central Bureau for Nuclear Measurements). 1968. 20p. Dep.

Angular distributions of neutrons elastically and inelastically scattered by ^{7}Li were measured at eight incident energies between 1.12 and 2.30 MeV, using a fast neutron time-of-flight spectrometer. The data were corrected for flux attenuation and multiple scattering in the sample and for effects due to finite geometry. Differential cross section results are expressed in the form of Legendre polynomial expansions. Evaluated total and total inelastic cross sections are presented. (auth)

29905 (INR-P-849/I/PL) L'ETUDE DE REACTION ^{6}Li(d,p)^{7}Li INDUITE PAR LES DEUTERONS DE BASSES ENERGIES. (Study of the ^{6}Li(d,p)^{7}Li Reaction Induced by Deuterons of Low Energy). Turkiewicz, I. M.; Turkiewicz, J.; Turos, A.; Cepurcenko, I. A.; Fryszczyn, B. (Institute of Nuclear Research, Warsaw (Poland)). 1967. 18p. (In French). Dep.

The angular distributions of protons from the reactions ^{6}Li(d,p$_0$)^{7}Li and ^{6}Li(d,p$_1$)^{7}Li were measured at deuteron energies of 1.48, 1.80, 2.04, 2.27, 2.49, 2.66, and 2.94 MeV. The experimental distributions were compared with those predicted by the Butler stripping theory and the Dar diffraction theory. It was established that these theories do not conform with the experimental results. (tr-auth)

29906 (ISS-67/49) SHORT RANGE DYNAMICAL CORRELATIONS IN THE ^{12}C NUCLEUS FROM ELASTIC ELECTRON SCATTERING. Ciofi degli Atti, C. (Istituto Superiore di Sanita, Rome (Italy). Laboratori di Fisica). Dec. 30, 1967. 9p. Dep.

The elastic electron form-factor of the ^{12}C nucleus was calculated using harmonic oscillator wave functions and Jastrow-type correlations. The best fit oscillator lengths are essentially state-dependent and agree with those found in (e,e'p) reaction. (auth)

29907 (ORO-1316-57) STUDY OF NUCLEAR STRUCTURE WITH THE COSMOTRON. Phillips, G. C. (Brookhaven National Lab., Upton, N. Y. European Organization for Nuclear Research, Geneva (Switzerland)). June 1967. Contract AT-(40-1)-1316. 22p. (CONF-670629-8). Dep. CFSTI.

From Symposium on Light Nuclei, Few Body Problems, and Nuclear Forces, Brela, Yugoslavia.

Some experiments in which a 1-GeV proton beam was used to probe nuclear structure are summarized. Specifically, the optical-model analysis of angular distributions for the elastic scattering of 1-GeV protons by ^{12}C, D, ^{4}He, H, and ^{16}O is discussed in detail. (D.C.W.)

29908 A SHELL-MODEL CALCULATION FOR THE REACTION ^{15}N(p,n)^{15}O. Hanna, J. S.; Nagarajan, M. A. (Case Western Reserve Univ., Cleveland). Nucl. Phys., A113: 412-32 (1968).

The unified theory of Feshbach is applied to the reaction ^{15}N(p,n)^{15}O. Two open channels for the elastically scattered proton and the inelastically scattered neutron are explicitly included. The open channels are coupled by the optical isospin-dependent potential of Lane. The closed-channel Hamiltonian is diagonalized in a restricted shell-model basis of one-particle–one-hole negative-parity states; the positions and widths of the resonances in ^{16}O due to the closed channels are compared with experiment. The total neutron cross section and angular distributions are also compared with experiment. Some differential excitation functions are presented for the elastically scattered proton. (auth)

29909 A STUDY OF THE MECHANISM OF THE ^{11}B(d,n)^{12}C REACTION BY MEANS OF NEUTRON–GAMMA CORRELATION MEASUREMENTS. Tepel, J. W.; Cosack, M.; Felst, R.; Zeitnitz, B. (Univ., Hamburg). Nucl. Phys., A113: 332-52(1968).

Reaction plane neutron–gamma angular correlations have been measured for the neutron group to the first excited state of ^{12}C at neutron detector angles of 0 and 162° for five deuteron energies between 1.6 and 3.3 MeV. The results are analyzed within the framework of the spin-dependent and spin-independent DWBA theories of stripping reactions. Possible contributions due to competing reaction mechanisms are discussed. In addition, correlation measurements are reported of the group to the 15.1-MeV state of ^{12}C at θ_n = 0° and $\bar{E}_d$ = 2.88 and 3.31 MeV. (auth)

29910 ANGULAR CORRELATION MEASUREMENTS IN THE ^{10}B(d,pγ)^{11}B REACTION. Comsan, M. N. H.; Farouk, M. A.; El-Kamhawy, A. A.; El-Tahawy, M. S. M.; Lvov, A. N. (Atomic Energy Establishment, Cairo). Z. Phys., 212: 71-82(1968).

Proton–gamma angular correlations through the 6.76- and 8.92-MeV excited states of ^{11}B are measured at deuteron bombarding energies from 1.6 to 2.4 MeV. The correlations are measured at laboratory proton scattering angles 35° in both reaction and azimuthal planes. The correlation coefficient A_2^2 and the distortion parameter λ are calculated. A systematic shift of the symmetry axis from the recoil direction is observed. This shift tends to zero as $E_d \rightarrow Q$. For the 8.92-MeV excited state of ^{11}B(Q = 0.32 MeV) the distortion parameter λ is close to the plane wave limit. The possible values of incoming channel spins as well as gamma-ray multipole mixing ratio for the 6.76- and 8.92-MeV states are obtained. (auth)

29911 AVERAGE LIFETIMES IN ^{16}O. Henneberg, P. (Max-Planck-Institut fuer Chemie, Mainz). Naturwissenschaften, 55: 80(Feb. 1968). (In German).

The following values were obtained for average lifetimes of various energy levels in ^{16}O: the 8.88-MeV(2-) level, 1.92 ± 0.80 × 10^{-13} sec; the 10.96-MeV(0-) level, <0.48 × 10^{-13} sec; and the 11.08-MeV(3+) level, 1.72 ± 0.60 × 10^{-13} sec. The ^{16}O was produced in TiN by ^{3}He reactions (^{3}He,p$\gamma\gamma$) with ^{14}N. (M.C.G.)

29912 DELAYED NEUTRON EMITTERS PRODUCTION IN THE BEAM OF THE ORSAY SYNCHROCYCLOTRON. Cabrespine, A.; Gauvin, H.; Lefort, M.; Sauvage, L. (Univ., Paris, Orsay, France). Ark. Fys., 36: 463-7(1967).

From International Symposium on Why and How Should We Investigate Nuclides Far Off the Stability Line, Lysekil, Sweden, See CONF-660817.

A method is described which permits the study of short half-

lives of delayed neutron emitters produced on various targets bombarded for short time intervals by a 150 MeV proton beam. ^{9}Li, ^{16}C, ^{17}N, and neutron rich nuclei produced in fission reactions were studied. (auth)

29913 DELAYED PROTONS FOLLOWING ^{3}He REACTIONS WITH OXYGEN, SILICON, AND SULFUR TARGETS. Fink, R. W.; Braid, T. H.; Friedman, A. M. (Argonne National Lab., Ill. Georgia Inst. of Tech., Atlanta). Ark. Fys., 36: 471-5(1967).

From International Symposium on Why and How Should We Investigate Nuclides Far Off the Stability Line, Lysekil, Sweden. See CONF-660817.

Delayed proton emission was studied from targets of O, in the form of Ta_2O_5, Sb_2O_5, and As_2O_3, giving the reaction ^{16}O(^{3}He,2n)^{17}Ne; from targets of elemental Si, giving the reaction ^{28}Si(^{3}He,2n)^{29}S; and from S targets in the form of elemental S, ZnS, and SnS, giving the ^{32}S(^{3}He,2n)^{33}Ar reaction. Experiments with a target of Teflon tape to study the ^{19}F(^{3}He,3n)^{19}Na reaction were also performed. Some of the results obtained are briefly summarized. (S.F.L.)

29914 DOPPLER-SHIFT LIFETIME MEASUREMENT ON THE 2.79-MeV LEVEL OF ^{19}F. Robinson, S. W.; Bent, R. D. (Indiana Univ., Bloomington). Phys. Rev., 169: 780-1(May 20, 1968).

The mean lifetime of the 2.79-MeV level of ^{19}F was determined by the Doppler-shift-attenuation method to be $\tau < 1.9 \times 10^{-13}$ sec. This result and other lifetime data on the low-lying members of the ground-state rotational band are compared with the predictions of the rotational model both with and without band mixing due to particle-rotation coupling. The existing experimental data are consistent with both sets of calculated lifetimes. (auth)

29915 HARTREE–FOCK AND HARTREE–BOGOLYUBOV CALCULATIONS IN P-SHELL NUCLEI. Faessler, Amand (Univ., Muenster, Ger.); Sauer, P. U.; Stingl, M. M. Z. Phys., 212: 1-31(1968).

Hartree-Fock (HF) and Hartree-Fock-Bogolyubov (HFB) calculations have been performed for the 1p shell nuclei. Nuclear deformations are assumed to be at most axially symmetric. The HFB transformation is restricted to allow for p-p and n-n pairing only. Volkov's force, a soft-core, two-body interaction of semi-realistic nature, is used which does not produce any single-particle spin-orbit splittings. Coulomb force and the usual correction for center-of-mass motion are taken into account. The calculations are carried out in a single-particle basis including all states up to principle oscillator quantum number N = 3 (in some cases, N = 4). Binding energies, rms radii, density distributions, and quadrupole moments are calculated and found to be in reasonable agreement with experiment. Large Hartree-Fock energy gaps are obtained. They prevent the pairing correlations considered from becoming effective in an HFB approach and from changing the HF ground-state properties appreciably. In non-selfconjugate nuclei, the Pauli principle, rather than the Coulomb interaction, yields large differences between the charge and mass distributions. A theorem on self-consistent symmetries is proved. The coefficients of the HFB transformation turn out to be real, if time-reversal and angular momentum projection flip are self-consistent symmetries. (auth)

29916 ^{7}Li(p,α)^{4}He REACTION WITH POLARIZED PROTONS FROM 0.8 TO 3 MeV. Petitjean, Claude (Univ. of Basel); Brown, Louis. Nucl. Phys., A111: 177-83(1968).

A polarized beam was used to measure the asymmetry in the angular distribution of the alpha particles from the ^{7}Li(p,α)^{4}He reaction at 2.07 and 3 MeV. The polarization efficiency $P_s(\Theta)$ can be fitted to the form $P_s(\Theta) = 1/W_0(\Theta)\,[A_2(E)P_2^1(\cos\Theta) + A_4(E)P_4^1(\cos\Theta)]$, where $W_0(\Theta)$ is the normalized angular distribution for unpolarized protons. At these energies, the coefficient $A_2(E)$ is much larger than $A_4(E)$. A polarization excitation function at $\Theta = 135°$(c.m.) was measured from 0.8 to 3 MeV in 0.1 MeV steps from which $A_2(E)$ is calculated. The data consist of 40 points that were measured typically to an accuracy of 2.2% with a target 110 keV thick at 2 MeV bombarding energy. A polarization contour map is given. (auth)

29917 NUCLEAR RECOIL IN THE ^{12}C(p,pn)^{11}C REACTION. II. ENERGY DISTRIBUTION. Panontin, J. A. (Argonne National Lab., Ill.); Schwartz, L. L.; Stehney, A. F.; Steinberg, E. P.; Winsberg, L. Phys. Rev., 169: 851-8(May 20, 1968).

The energy distribution of the recoiling ^{11}C atoms from the reaction ^{12}C(p,pn)^{11}C, induced by 450-MeV protons, was measured at eight laboratory angles between 30 and 150° to the beam direction. The contribution of various mechanisms to the total cross section is estimated, and a direct knockout mechanism is shown to predominate—if, indeed, a distinction among the different mechanisms can be made in such light nuclei. The results are compared with a distorted-wave calculation of Benioff and Person. (auth)

29918 (p,xp) AND (p,xp$\gamma\alpha$) REACTIONS OF 156-MeV PROTONS WITH LIGHT TARGETS (A = 11 TO 27). Dostrovsky, I. (Weizmann Inst. of Science, Rehovoth, Israel); Gauvin, H.; Lefort, M. Phys. Rev., 169: 836-41(May 20, 1968).

The formation cross sections of ^{9}Li, ^{16}C, and ^{17}N from B, C, ^{14}N, ^{15}N, ^{16}O, ^{18}O, F, Ne, Na, Mg, and Al targets bombarded with 156-MeV protons were measured by means of their neutron emission. The results were compared with calculations based on the two-step spallation mechanism. Certain reactions were shown to provide direct comparison with prompt cascade calculation. In general, the agreement between theory and experiment was good, and it is suggested that some discrepancies are attributable to the neglect of the effect of nuclear structure in the calculations. The importance of α emission in determining the pattern of spallation product cross section was demonstrated. (auth)

29919 PHOTODISINTEGRATION OF ^{16}O. Denisov, V. P.; Komar, A. P.; Kulchitsky, L. A. (Ioffe Inst. of Physics and Tech., Leningrad). Nucl. Phys., A113: 289-302(1968).

Photoproton spectra from the reaction ^{16}O(γ,p)^{15}N were measured at 24 bremsstrahlung end-point energies. Cross sections were obtained for the transitions to the ground, 5.28 + 5.30, and 6.35 MeV states of ^{15}N. (auth)

29920 PHOTOTRITON CROSS SECTION OF ^{6}Li. Sherman, N. K.; Baglin, J. E. E.; Owens, R. O. (Yale Univ., New Haven). Phys. Rev., 169: 771-9(May 20, 1968).

The phototriton cross section of ^{6}Li was measured between 24- and 35-MeV photon energy. This work complements an earlier experiment which established the production of the ^{6}Li(γ,t) reaction by giant-resonance photons and measured the cross section between 19 and 24 MeV. The phototriton cross section of ^{6}Li falls monotonically from 0.46 ± 0.24 mb at 19 MeV to 0.11 ± 0.06 mb at 35 MeV. The integrated (γ,t) cross section over this energy interval is 4.9 ± 2.5 MeV mb. The measured bremsstrahlung-weighted cross section is 0.18 ± 0.09 mb. Implications concerning the nuclear size are discussed. (auth)

29921 POLARIZATION-VECTOR ANALYZING POWER OF THE REACTIONS ^{9}Be(d,p)^{10}Be AND ^{12}C(d,p)^{13}C. Baxter, A. M.; Griffith, J. A. R.; Roman, S. (Univ. of Birmingham, Eng.). Phys. Rev. Lett., 20: 1114-16(May 13, 1968.

Measurements were made of the vector analyzing power for polarized deuterons of 12 MeV of the reactions ^{12}C(d,p)^{13}C, ^{12}C(d,p)^{13}C* (3.09-MeV state), and ^{9}Be(d,p)^{10}Be. For the first of these reactions, a comparison was made with proton-polarization measurements at a nearby energy. (auth)

29922 PRODUCTION OF ^{6}He BY THE BOMBARDMENT OF ^{7}Li, ^{10}B, AND ^{11}B BY ^{7}Li. Stryk, Robert A.; Blair, J. M. (Univ. of Minnesota, Minneapolis). Phys. Rev., 169: 767-70(May 20, 1968).

The angular distributions of ^{6}He produced in the reactions ^{7}Li(^{7}Li,^{6}He)^{8}Be, ^{10}B(^{7}Li,^{6}He)^{11}C, and ^{11}B(^{7}Li,^{6}He)^{12}C were studied with lithium ions having energies of 3.0, 3.5, and 3.8 MeV. The yields were nearly isotropic in the center-of-mass system, except for that from ^{10}B, which was peaked in the forward direction. These reactions apparently proceed by a mechanism more complex than the transfer of a proton from one nucleus to another. (auth)

29923 REACTIONS INDUCED BY ACCELERATED LITHIUM NUCLEI. Chuev, V. I.; Davidov, V. V.; Ogloblin, A. A.; Sakuta, S. B. (Kurchatov Atomic Energy Inst., Moscow). Ark. Fys., 36: 263-6(1967).

From International Symposium on Why and How Should We Investigate Nuclides Far Off the Stability Line, Lysekil, Sweden. See CONF-660817.

Spectra and angular distributions of the (^{7}Li,t) reaction on ^{6}Li and ^{12}C at a beam energy of 27.5 MeV and spectra at 30° of the (^{6}Li,α) reaction on ^{6}Li, ^{7}Li, ^{9}Be, and ^{12}C at a beam energy of 26 MeV were measured. Excitations of some levels of the residual nuclei were observed, which seem to be connected with a transfer of an α- or d-cluster. Formation of continuous spectra due to dissociation of ^{6}Li and ^{7}Li were also observed. (auth)

29924 REACTIONS WITH PROTONS ON NITROGEN. Shrivastava, P. N.; Borelli, F.; Kinsey, B. B. (Univ. of Texas, Austin). Contract AT(40-1)-2972. Phys. Rev., 169: 842-50 (May 20, 1968). (ORO-2972-45).

The yields and angular distributions of the charged particles produced on bombardment of nitrogen by protons were studied in the range of 6- to 9-MeV incident proton energy. The cross section of the (p,α) reaction is much larger than that of the reaction producing ^{3}He or inelastic scattering of protons to the first four excited states of ^{14}N. A broad resonance (roughly 800 keV in width) was found in the (p,α) reaction centered at a proton bombarding energy of 7.5 MeV. The angular distribution of the p_1 proton group

(leading to the first excited state of ^{14}N) shows that the spin and parity of this resonant state is $^3/_2^-$. There is evidence for an additional broad $^3/_2^+$ state centered at 6.6 MeV. Sharp resonances appear superposed on these broad resonances in the (p,α) reaction; for most of these the α-particle yield is much larger than the proton yield. Some sharp resonances appear only in the (p,α) reaction. The reduced α-particle widths are usually of the order of a few percent of the Wigner limit, and 10 times higher than the reduced widths to the Wigner limit for neutron and proton emission. (auth)

29925 RECENT WORK ON DELAYED NEUTRON AND PROTON EMITTERS. Poskanzer, A. M. (Univ. of California, Berkeley). Ark. Fys., 36: 469-70(1967).

From International Symposium on Why and How Should We Investigate Nuclides Far Off the Stability Line, Lysekil, Sweden. See CONF-660817.

The decay of the delayed neutron emitter ^8He was observed using a new method of fast chemistry. The isotope was produced by 2-GeV proton bombardments of cotton targets. The decay curve obtained by neutron counting is given. (S.F.L.)

29926 RESEARCH ON THE REACTION $^{16}O(d,p)$ PRODUCT WITH THE THIN OXYGEN LAYER ON THE SURFACE OF METALS. Cuypers, M. (Univ., Liege); Quaglia, L.; Robaye, G.; Dumont, P.; Barrandon, J. N. pp 371-88 of Proceedings of the 2nd Conference on Practical Aspects of Activation Analysis with Charged Particles, Liege (Belgium), September 21-22, 1967. Ebert, H. G. (ed.). Brussels, European Atomic Energy Community (EURATOM), 1968. (In French).

See EUR-3896; CONF-670947.

The deuteron beam from the Van de Graaff accelerator was used to study the surface oxidation of metals (Al, Zr, and stainless steel) by the (d,p) reaction on ^{16}O leaving the ^{17}O nucleus in the first excited state. Range of thicknesses was 1 to 10 μg/cm². A description of experimental set-up and associated electronics is given. The reaction relative differential cross-section at 156°C was measured between 400 and 2000 keV. A survey of the influence of experimental conditions such as intensity of the beam, beam-power, vacuum conditions, target cooling, etc., is included. (auth)

29927 SHELL-MODEL CALCULATIONS OF B(E2) VALUES IN s-d SHELL NUCLEI WITH A = 18 TO 22. Halbert, E. C.; McGrory, J. B.; Wildenthal, B. H. (Oak Ridge National Lab., Tenn.). Phys. Rev. Lett., 20: 1112-14(May 13, 1968).

The energy levels and E2 transition probabilities for the low-lying states of some sd-shell nuclei with A = 18 to 22 were calculated using a shell model with a realistic effective interaction. The effective interaction was derived from the Hamada-Johnston potential by reaction-matrix techniques, and it included some perturbative corrections associated with breaking of the 16-particle core. The strong similarity between these shell-model predictions and those obtained within the framework of a Nilsson-rotational model is discussed. (D.C.W.)

29928 THE $^{12}C(\gamma,n)^{11}C$ CROSS SECTION INVESTIGATED BY MEANS OF MONOENERGETIC GAMMA RADIATION OF VARIABLE ENERGY. Johansson, S. A. E.; Nilsson, L. (Univ. of Lund, Sweden). Ark. Fys., 35: 403-10(1968).

An investigation of a possible resonance structure in the cross section of the reaction $^{12}C(\gamma,n)^{11}C$ was studied by using monoenergetic gamma radiation from the reaction $^7Li(p,\gamma)^8Be$. The gamma-ray energies were modulated by the proton energy. A toluene sample was bombarded by the gamma radiation, and the resulting ^{11}C activity was measured by means of the annihilation coincidences in two large sodium iodide crystals. The gamma-ray flux monitored by means of silver plates close to the lithium target and the ^{106}Ag activity were measured by the same means as the carbon activity. The $^{12}C(\gamma,n)^{11}C$ cross section was investigated over an energy range of 19.0 to 19.7 MeV. The cross-section curve appears to be fairly smooth but there were some irregularities which might be broad resonances. However, the actual resolution indicated none. (auth) (Sweden)

29929 THE REACTION $^{10}B(d,\alpha)^8Be$ IN THE ENERGY REGION OF 0.5 TO 2.0 MeV. Friedland, E.; Verleger, H. (Univ. of Pretoria, S. A.). Z. Phys., 211: 373-9(1968). (In German).

Angular distributions of the α_0 group and the α_1 group were measured at 6 energies between 0.5 and 1.0 MeV, and the coefficients of the Legendre polynomials were calculated. Also given are relative cross-section curves for the two α groups between 0.5 and 2.0 MeV. The possibility of explaining the α_0 excitation curve by assuming only a few broad compound state resonances is discussed. (auth)

29930 THE REACTIONS $^{12}C(n,\gamma)^{13}C$ AND $^{19}F(n,\gamma)^{20}F$. Spilling, P.; Gruppelaar, H.; De Vries, H. F.; Spits, A. M. J. (Univ., Utrecht). Nucl. Phys., A113: 395-411(1968).

Gamma rays from thermal-neutron capture in ^{12}C and ^{19}F were studied with a Ge(Li) detector. In the $^{19}F(n,\gamma)^{20}F$ reaction, 73 γ-lines were found, of which 66 could be fitted into the level scheme of ^{20}F. The energies of two γ rays observed in the $^{12}C(n,\gamma)^{13}C$ reaction are determined as 1261.76 ± 0.07 and 3684.28 ± 0.10 keV. The energy of the γ ray emitted from ^{16}O produced in the reaction $^{19}F(n,\alpha)^{16}N(\beta^-)^{16}O^*$ is determined as 6129.6 ± 0.4 keV. The Q-values of the following reactions were determined: $^6Li(n,\gamma)^7Li$, Q = 7250.0 ± 0.5 keV; $^{12}C(n,\gamma)^{13}C$, Q = 4946.03 ± 0.15 keV; $^{19}F(n,\gamma)^{20}F$, Q = 6601.1 ± 0.3 keV; and $^{56}Fe(n,\gamma)^{57}Fe$, Q = 7645.9 ± 0.5 keV. (auth)

29931 YIELD OF ALPHA PARTICLES FROM LITHIUM FILMS BOMBARDED BY AN ANALYZED PROTON BEAM. Lee, Chul Chu; Koh, Youn Kyu; Kim, Do Kyong (Yonsei Univ., Seoul). J. Nucl. Sci. (Seoul), 7: No. 1, 55-61(Oct. 1967).

A description of the analyzing chamber and magnet used to analyze the proton beam is given. A 300-keV Cockcroft–Walton proton accelerator is used, and alpha yields at proton energies from 80 to 200 keV are presented. (W.H.K.)

29932 YIELDS AND ANGULAR DISTRIBUTIONS OF GAMMA RAYS FROM THE $^7Li(p,\gamma)^8Be$ REACTION. Nilsson, L.; Bergqvist, I. (Univ. of Lund, Sweden). Ark. Fys., 35: 411-21(1968).

The $^7Li(p,\gamma)^8Be$ reactions were studied in the proton energy range 1.4 to 2.5 MeV. The yield and angular distributions of the gamma-ray transitions in the ground state and the first excited state in ^8Be were measured by using a NaI(Tl) scintillation crystal 10.2 cm long and 12.7 cm in diameter allowing separation of the two gamma-ray components. The yield of the transition to the first excited state gave a broad resonance at a proton energy of about 2.1 MeV, where the angular distribution becomes almost isotropic. No resonance structure was observed in the yield of the ground state transition. From the analysis of angular distributions and from arguments on transition probabilities it is only possible to restrict the assignments for the corresponding 19.05-MeV level in ^8Be to $J^\pi = 1^+$, 2^+, or 3^+. At present there seems to be no other convincing argument to exclude any of these possibilities. (auth) (Sweden)

29933 ANGULAR CORRELATION OF INELASTICALLY SCATTERED NEUTRONS AND THE ASSOCIATED GAMMA RAYS FROM ^{12}C AT E_N = 14.65 MeV. Gilpatrick, Michael W. Athens, Ohio, Ohio Univ., 1967. 126p.

Thesis.

The angular correlation between neutrons inelastically scattered from the first excited state of ^{12}C (Q = −4.43 MeV) and the associated de-excitation gamma rays was measured. The neutrons were produced by the $t(d,n)^4He$ reaction by accelerating deuterons to 150 keV in a direct current accelerator. To allow discrimination between elastic and inelastically scattered neutrons, the associated particle time-of-flight technique was used. Both neutron and alpha particle detectors were plastic scintillators. The gamma-ray detector was a liquid scintillator, and the pulse shape discrimination technique was used to eliminate background neutrons, to which this scintillator was sensitive. The angular correlation was measured for a range of neutron scattering angles with the gamma-ray detector placed at 90° to the incident neutron beam both in the reaction plane and perpendicular to it. The neutron system efficiency was determined by observing neutrons elastically scattered from free protons which were contained within a polyethylene (CH_2) sample, and normalizing these data to the calculations of Breit. Similarly, the gamma-ray system efficiency was calculated from the observed intensity of gamma-ray production from the reaction $^{12}C(n,n'\gamma)^{12}C$, and normalizing it to the value of this cross section given by Nellis, et al. The analysis of the correlation data embodied corrections for both random and correlated accidental coincidences. The data have been analyzed in terms of the distorted-wave Born approximation. The results of Nagarajan show that the predicted correlations are quite sensitive to the choice of target nucleus wave functions. In particular, configuration-mixed shell model wave functions for the first 2+ state in ^{12}C do not adequately fit the experimental correlations, whereas greatly improved agreement seems to be possible if a deformed nucleus model is used for ^{12}C. The optical potential used to calculate the distorted waves was similar to that used by Banerjee and Levinson. The measured double differential cross sections for both the in-plane and out-of-plane measurements are presented. (Disser. Abstr.)

29934 CHARGE DEPENDENCE OF THE NUCLEAR FORCES AND THE A = 14 ISOBARIC TRIPLET. Jalbert, Jeffrey Scott. Blacksburg, Va., Virginia Polytechnic Inst., 1967. 138p.

Thesis.

Two equations are obtained for the four parameters specifying the charge-dependent two-nucleon potential that was suggested by Blin–Stoyle and Le Tourneux. To do this, new wave functions for the first few low-lying levels of the A = 14 isobaric triplet

^{14}O, ^{14}N, and ^{14}C are found. These wave functions contain contributions from the 2s-1d shell as well as the normal 1p shell components. The method used is a variant of the effective interaction procedure. The wave functions, so obtained, describe the ground-state magnetic dipole and electric quadripole moments as well as the M1 gamma transition from the first excited state of ^{14}N to its ground state. The energy separation of the first isobaric triplet of levels is then computed using these wave functions for the charge-dependent Coulomb and spin–orbit forces. The residual shifts are attributed to the charge-dependent nuclear force, and two equations for the four parameters are obtained. (Diss. Abstr.)

29935 ENERGY LEVELS OF ^{17}O FROM THE REACTION $^{16}O(d,p)^{17}O$. de Forest, Felix George. Madison, Wis., Univ. of Wisconsin, 1967. 165p.

Thesis.

Angular distributions of differential cross sections of the reaction particles from the reaction ^{16}O + d were measured for the particles d_0, p_0 through p_8, and α_0. Measurements were made at the six incident deuteron energies of 6.00, 6.35, 6.90, 7.48, 7.85, and 8.55 MeV, at 24 angles between 15 and 165° in the laboratory system. The data were recorded with solid-state (silicon) detectors used either singly or in a counter telescope pair, in a differentially pumped gas scattering chamber with a target thickness ≤5 keV. The systematic uncertainties of the data amounted to about 1.1%. Protons from the decay of $^{17}F^*$ formed in its excited states in the competing (d,n) channel caused interference with the p_4 and higher direct proton groups leading to ^{17}O. The yields of these direct proton groups were corrected for the presence of the protons from the $^{17}F^*$ decay using kinematical considerations only. Proton groups, or two groups of different kinds of particles, close enough together in energy so as to overlap seriously with each other were separated using a computer program which fitted the experimental spectra with a background plus a number of Gaussian-shaped peaks, the parameters of which were variable. When the peaks were difficult to separate, constraints could be imposed on some of the peak parameters to achieve convergence of the fit. The angular distributions of the proton groups p_0, p_1, and p_8 exhibited a regularity of shape indicative of a predominantly stripping process to the corresponding good single particle levels in ^{17}O. The other proton groups exhibited a more or less fluctuating shape, particularly beyond an angle of about 60°, thus indicating a predominantly non-stripping character for the transitions to these levels. However they also showed a quite consistent stripping-like edge at lower angles. An attempt to identify the spin of the sixth excited state, which is not seen in the elastic scattering of neutrons on ^{16}O, and for which no counterpart in the mirror nucleus ^{17}F has been reported in the literature, was only partially successful. Two methods of analysis were attempted: a plane wave fit to the leading edge of the p_8 distributions up to an angle of about 70°, assuming this edge to be a stripping phenomenon, and an attempt to correlate the total cross section with J_f, the spin of the final state. This assumption, that the sixth and the negative parity states of ^{17}O obey such a relation, is based in turn on the assumption that the varying shape of the distributions beyond 60° indicate a compound nucleus mechanism to these final levels. The plane-wave fits failed to yield a unique l-assignment, because for transitions to unbound final states there is too little differentiation in shape between the predictions for the various l-values. The second method, involving the proportionality between σ_{TOT} and J_f, did not yield an unambiguous assignment for J_f of the sixth excited state. A tentative assignment for J_8 is $^5/_2$ or $^5/_2$. The assignment is not definite, however, as the experimental conditions under which the data were taken did not satisfy all the requirements necessary for this J_f proportionality to be valid, and also because this relationship was found to be not too linear for the other states, and on which the assignment for J_8 is based. Distorted-wave fits were made to the angular distributions of d_0 and p_0. The optical potential parameters which fitted data from the reaction ^{12}C + d gave reasonable fits for this reaction also; in particular a potential depth of about 50 MeV/nucleon, and a surface absorption potential of about 16 MeV at 6-MeV bombarding energy and slowly increasing with energy. The resultant spectroscopic factor for the ground state of ^{17}O lay between 0.9 and 1.1. The fits to the p_0 distributions seemed about equivalent for local and non-local potentials; they were however somewhat better when spin-orbit potentials were included than when they were omitted. Also the fit improved with increasing bombarding energy. (Diss. Abstr.)

29936 EXPERIMENTAL INVESTIGATION OF PARTICULAR FINAL-STATE DECAY MODES FOLLOWING PHOTO-PARTICLE REACTIONS IN ^{16}O. Caldwell, John Thomas. Davis, Calif., Univ. of California, 1967. 127p.

Thesis.

Two independent experiments investigating particular final-state decay modes following photo-particle reactions in ^{16}O were carried out with monoenergetic photons over the giant resonance region of 17 to 29 MeV. In the first experiment, a 4 π neutron detector-spectrometer was used to obtain information on ground and excited-state transitions in the ^{16}O (γ,n) reaction. In the second, de-excitation γ-rays following ^{16}O (γ,nγ′; γ,pγ′; and γ,αγ′) reactions were detected. By combining the results of the two experiments, a total of twelve individual decay-mode cross sections was determined, including three sets of ^{15}O–^{15}N mirror-level decays and the ^{16}O (γ,αγ′) ^{12}C (15.1 MeV final state) reaction. Seven of these decay modes had not been observed previously, and none had been investigated with monochromatic photons. By summing up all of the ^{16}O decay cross sections determined in this experiment and adding in the ^{16}O (γ,p) ^{15}N ground-state cross section, a total absorption cross section was determined that agrees well with direct total absorption measurements. A total of 78 ± 8% of all decays observed up to 29 MeV are either to the $^1/_2^-$ ground state of $^3/_2^-$ third-excited states of ^{15}N and ^{15}O. This must be regarded as major evidence for the basic validity of the single-particle, single-hole theory of photo-excitations in ^{16}O. A comparison of the experimental $^1/_2^-$ and $^3/_2^-$ cross sections with recent detailed particle-hole calculations indicates reasonable agreement between theory and experiment. The present data indicate that an elaboration of this theoretical work to include only a few specific two-particle, two-hole configurations might result in still better agreement and provide for other than $^1/_2^-$ and $^3/_2^-$ state decay modes. 15% of the total transition strength up to 29 MeV is divided between the ($^1/_2^+$, $^3/_2^+$) and $^3/_2^+$ ^{15}O and ^{15}N final-state decays. The pairs of mirror-level decays were used to determine the T = 0 isobaric spin impurity in giant resonance states of ^{16}O. The average T = 0/T = 1 amplitude ratio is in the neighborhood of 0.08 over the entire giant resonance, but considerable structure does occur, with maximum values at excitation energies of 20.1, 22.4, 25.3, 27.3, and ≥28.3 MeV. The ratios of specific decay-mode cross sections to the total absorption cross section reveal a strong variation of σ_i/σ total absorption over the giant resonance. These ratios should be quite helpful in determining future steps to be taken in ^{16}O shell-model calculations. The ^{16}O (γ,αγ′) $^{12*}C$ (15.1 MeV, T = 1, $J^\pi = 1^+$) reaction apparently proceeds through just the single 25.2-MeV state of ^{16}O. A width of 1.4 MeV, T = 1, and J^π probably 1^- or 1^+ were determined for the 25.2-MeV state from this cross section data. There is an indication of a strong configurational relationship between the 15.1-MeV ^{12}C and 25.2-MeV ^{16}O states. (Disser. Abstr.)

29937 ^6He PRODUCTION IN LOW-ENERGY ^7Li REACTIONS. Stryk, Robert Anthony. Minneapolis, Univ. of Minnesota, 1967. 72p.

Thesis.

The absolute angular distribution of helium-6 produced by 3.0-, 3.5-, and 3.8-MeV lithium-7 upon lithium-7, boron-10, and boron-11 was measured. The helium-6 was detected by its beta decay in a chopped-beam experiment. In a chopped-beam experiment the beam is periodically turned on and off. The events which occur when the beam is off are analyzed. The theory of chopped beam experiments is derived. Large errors were caused by gaseous helium-6 in the vacuum system. Energy resolution sufficient to separate excited states was provided by energy degrading foils. Forward peaking was observed for boron-10 and boron-11 with the residual nucleus, carbon-12, in its first and second excited states. The remaining distributions are isotropic within errors. The Coulomb-distorted wave approximation fails to give the observed distributions. The target material, highest average beam energy, and total cross sections for the ground and excited states were; lithium-7, 3.65 MeV, 2.5 ± 1.5 mb, 5.3 ± 2.0 mb; boron-10, 3.59 MeV, 0.10 ± 0.03 mb; boron-11, 3.65 MeV, 0.64 ± 0.64 mb, 1.03 ± 0.57 mb, 0.4 ± 0.2 mb. The lithium-7 target also produces beryllium-10 in excited states which decays to alpha particles and helium-6. This reaction produces a large number of low-energy helium-6 at forward angles in the laboratory. A computer program for non-linear least squares curve fitting is described. (Diss. Abstr.)

29938 STRUCTURE-DEPENDENT ASYMMETRY IN SEQUENTIAL BREAKUP FROM THE REACTION $^6Li(^3He,p\alpha)^4He$. Reimann, Michael Andrew. Vancouver, Univ. of British Columbia, 1967.

Thesis.

An axial asymmetry about the direction of motion of ^5Li was seen in the breakup of the ground state of this nucleus as an intermediate state in the reaction $^6Li(^3He,p\alpha)^4He$. The total cross section for this process was found to be a few hundred millibarns, an order of magnitude greater than predicted by a statistical model calculation, and the asymmetry amounts to a factor of 2.0 ± 0.3 in the double differential cross section. It is shown that this asymmetry in the secondary decay of the sequential breakup process can arise from the memory retained by the intermediate state of its structure during the primary reaction, in which a neutron is transferred from ^6Li to ^3He. It was found that the strength

of the asymmetry is sharply dependent upon the duration of the final-state interaction. This confirms the proposed interpretation, and suggests that further data could lead to useful information regarding correlation of the p-shell nucleons in the ^{6}Li ground state. (Diss. Abstr.)

29939 STUDY OF INTERACTIONS OF 16- TO 29-MeV PROTONS WITH BERYLLIUM. Montague, Daniel Grover. Los Angeles, Univ. of Southern California, 1966. Thesis.

Proton-induced reactions with the ^{9}Be nucleus were studied experimentally at four energies from 16 to 29 MeV. Angular distributions of the elastic and inelastic protons were measured simultaneously with the angular distributions of deuterons from the (p,d) reaction to the ground state and the first excited state of ^{8}Be. These measurements were performed with incident protons of 17, 21, 25, and 29 MeV laboratory energy. Protons and deuterons were identified using a delta-E and E detector telescope with an electronic identification circuit. The proton total reaction cross section for beryllium was measured in the energy range 16 to 28 MeV. This cross section was determined experimentally by comparing the number of protons going into a target with the number of protons coming out, from which the attenuation of the proton beam was calculated. Diffuse surface optical model analyses of these elastic and reaction cross section data, the previously published elastic scattering data at 18.9 and 31.3 MeV, and the polarization data at 17.8 MeV were done. The results of these theoretical calculations are compared to the parameters from theoretical fits to experimental data on other elements in this energy range. (Diss. Abstr.)

Nuclear Properties and Reactions, $20 \leq A \leq 89$

Refer also to abstracts 27625, 28097, 28148, 29804, 29830, 29900, 29912, 29913, 29918, 29927, 29930, 29994, 30006, 30013, 30033, 30044, 30048, 30051, 30063, 30067, 30068, 30086, 30100, and 30102.

29940 (AECD/TP-23) THE AKHIESER–POMERANCHUK–BLAIR MODEL ANALYSIS FOR ELASTIC SCATTERING OF DEUTERONS. Rahman, M.; Khan, A. H.; Sen Gupta, H. M. (Atomic Energy Centre, Dacca (Pakistan)). Nov. 1967. 10p. Dep.

Angular distributions of deuterons elastically scattered from Mg, Fe, Cu, and Zn were analyzed in terms of the smoothed Akhieser-Pomeranchuk-Blair model; reasonable agreement was obtained in each case up to about 90°. The interaction radius R and the surface thickness ΔR were obtained from the best-fit parameter-values. (auth)

29941 (IPNO/TH-118) POTENTIAL SCATTERING BY A NUCLEAR HARTREE–FOCK FIELD. Vautherin, D.; Veneroni, M. (Paris Univ., Orsay (France). Institut de Physique Nucleaire). Feb. 1968. 13p. Dep.

The Hartree–Fock spectra of ^{16}O and ^{40}Ca nuclei are calculated in coordinate space. In lowest order, the continuum states correspond to neutron elastic scattering. Phase shifts are given, and single-particle resonances are discussed. (auth)

29942 ALPHA–ALPHA INTERACTION IN ^{40}Co AND ^{36}Ar. Khanna, K. M.; Bhattacharya, P. (Indian Inst. of Tech., Kharagpur). Indian J. Pure Appl. Phys., 5: 511-15(Nov. 1967).

The momentum transferred in transition from the ground state to the first excited state for a nuclear system consisting of equal number of protons and neutrons was calculated assuming for the atomic nucleus an α-particle structure. The matrix elements of interaction potential, consisting of direct (TPEP) potential $V_D(r)$ and Coulomb repulsive potential $V_C(r)$, were calculated considering only pair interaction between α particles. An expression for the different energy states available to the system was derived in terms of momentum transfer which was calculated for ^{40}Ca and ^{36}Ar taking only one of the above-mentioned potentials at a time. (auth)

29943 ATOMIC-BEAM INVESTIGATIONS OF SHORT-LIVED NUCLEI. Lindgren, Ingvar; Olsmats, Mats (Chalmers Univ. of Tech., Goteburg. Univ. of Uppsala). Ark. Fys., 36: 155-6 (1967).

From International Symposium on Why and How Should We Investigate Nuclides Far Off the Stability Line, Lysekil, Sweden. See CONF-660817.

The atomic beam technique is briefly discussed as a means of measuring spins and moments of short-lived nuclear states. A table is given which shows the estimated minimum production rates that are required for a spin determination. (S.F.L.)

29944 AVERAGED INTENSITIES OF PRIMARY GAMMA RAYS AFTER keV NEUTRON CAPTURE IN COPPER. Allen, B. J. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Nucl. Phys., A111: 1-11(1968).

The averaged intensities of high-energy gamma rays in Cu were measured with a Ge(Li) detector after the capture of 10 to 60 keV neutrons. The capture spectra represent the average strengths of transitions from a large number of resonances. They bear no relation to the thermal result, thus supporting the view that the latter proceeds through a non-compound nucleus mechanism. The ground state transition does not dominate the keV capture spectrum and the intensities indicate the presence of an E_γ^3 energy dependence. (auth)

29945 COMPLETE-FUSION COLLISIONS IN HEAVY-ION REACTIONS. Kowalski, L.; Jodogne, J. C.; Miller, J. M. (Columbia Univ., New York). Contract AT(30-1)-1019. Phys. Rev., 169: 894-8(May 20, 1968). (CU-1019-66).

Cross sections for compound-nucleus formation were experimentally measured for the ^{16}O + ^{27}Al, ^{20}Ne + ^{27}Al, and ^{16}O + ^{59}Co systems by means of mica track detectors. It was shown that the cross section for compound-nucleus formation (complete fusion) above 100 MeV decreases with increasing energy of the bombarding particles, whereas the reaction cross sections increase slightly. An attempt was made to explain this behavior by considering a sharp cutoff in the spin distribution of the compound nuclei. (auth)

29946 COUPLED-CHANNEL AND MICROSCOPIC ANALYSIS OF THE "QUASI-ELASTIC" AND "QUASI-INELASTIC" Ti(^{3}He,^{3}H) DATA. Wesolowski, J. J. (Univ. of California, Livermore); Schwarcz, Ervin H.; Roos, P. G.; Ludemann, C. A. Contract W-7405-eng-48. Phys. Rev., 169: 878-88(May 20, 1968). (UCRL-70701)

The (^{3}He,^{3}H) reaction differential cross sections for all the stable Ti isotopes were measured at a ^{3}He bombarding energy of 24.6 MeV. Information about the strength and shape of the isobaric-spin-dependent potential is obtained from a comparison of the "quasi-elastic" data, with theoretical angular distributions obtained using a coupled-channel formalism. These calculations are compared with the results of calculations using the less exact distorted-wave Born-approximation (DWBA) formalism. The shape and strength of the effective nucleon-nucleon interaction in nuclear matter is obtained from comparisons of the data with calculations made using a microscopic model. The results are compared with those obtained from an analysis of (p,n) data. Finally, an analysis of "quasi-inelastic" transitions to excited isobaric states is made in terms of the collective-model description of inelastic scattering. (auth)

29947 DECAY OF 9.3-h ^{62}Zn TO ^{62}Cu. Bakhru, H. (Yale Univ., New Haven). Contract AT(30-1)-3909. Phys. Rev., 169: 889-94(May 20, 1968). (YALE-3909-H-98).

The excited levels of ^{62}Cu were investigated from the decay of ^{62}Zn with Ge(Li), Si(Li), and standard scintillation counters. γ rays of energy 0.042, 0.245, 0.260, 0.395, 0.505, 0.547, 0.595, and 0.682 MeV were observed to decay with a half-life of 9.3 h. With the help of γ-γ coincidence study, a consistent scheme of levels at 0.042, 0.287, 0.547, 0.637, and 0.682 MeV in ^{62}Cu was obtained. The spin and parity assignments of some of the excited levels of ^{62}Cu are discussed. The half-life of the 42-keV level is measured by delayed coincidence to be $2.5 \pm 0.1 \times 10^{-9}$ sec. (auth)

29948 DECAY OF ^{72}Zn. Kjelberg, A. (CERN, Geneva); Hageboe, E.; Nordhagen, R. Nucl. Phys., A111: 193-200(1968).

The decay of ^{72}Zn was studied using high-resolution spectroscopic techniques for conversion electrons and gamma rays. Gamma transitions of energies 16.4, 41.9, 46.8, 79.4, 88.7, 102.8, 112.1, 147.7, and 191.5 keV were established. The 88.7 keV transition was found to feed the 102.8 keV isomeric transition of 37 msec ^{72m}Ga. The isomeric level probably has $J^\pi = 0^+$. A consistent decay scheme including all available information is proposed. (auth)

29949 DELAYED NEUTRON EMISSION AND PRECURSORS: STATUS 1966. Pappas, A. C.; Tunaal, T. (Univ. of Oslo). Ark. Fys., 36: 445-52(1967).

From International Symposium on Why and How Should We Investigate Nuclides Far Off the Stability Line, Lysekil, Sweden. See CONF-660817.

The physical explanation of delayed neutron emission and the development of delayed neutron systematics based on energetics and spin considerations is reviewed. Delayed neutron emission from fission products is commonly resolved into six groups with half-lives ranging from about 55 sec. to about 0.2 sec. Each of these groups is reported to be composites mainly of isotopes of bromine and iodine, although the isotopes ^{92}Kr or ^{93}Kr, ^{94}Kr, ^{92}Rb

or ^{93}Rb, ^{88}As, and possibly ^{135}Sb are also reported to be delayed neutron precursors. In addition delayed neutron precursors from spallation fragments are known (^{9}Li, ^{16}C, ^{17}N, ^{210}Tl) while others possibly with masses between 50 and 60 have been observed, but are not yet identified. Delayed neutron yields from fission in relation to incident particle energy and the fissioning nucleus are also reviewed. (auth)

29950 GAMMA RAYS FROM THERMAL NEUTRON CAPTURE IN NATURAL NEON. Jonsson, L.; Hardell, R.; Arnell, S. E. (Chalmers Univ. of Tech., Goteborg). Ark. Fys., 35: 423-34(1968).

Thermal neutron capture gamma rays from natural neon were measured by means of Ge(Li) spectrometers. Energies and intensities of the gamma rays from the product nuclei ^{21}Ne and ^{23}Ne are reported. Decay schemes of ^{21}Ne and ^{23}Ne are given where new negative-parity states are proposed. The ratio between the thermal neutron capture cross sections of ^{20}Ne and ^{22}Ne were measured and were found to be 1.06 ± 0.10. (auth) (Sweden)

29951 INVESTIGATION OF THE ^{29}Si(p,γ)^{30}P REACTION AT PROTON ENERGIES 1460 TO 1860 keV. Bergstroem-Rohlin, S. (Univ. of Helsinki). Ark. Fys., 35: 349-56(1968).

In the reaction ^{29}Si(p,γ)^{30}P the gamma decay of the resonances at 1470, 1505, 1639, 1664, 1669, 1686, 1746, 1771, and 1852 keV were studied. The 1664- and 1852-keV resonance states decay entirely through the 2.94-MeV level in ^{30}P. The 1669-keV resonance state feeds the 3.02- and 5.50-MeV levels. The decay of the 5.50-MeV level proceeds entirely through the 0.68-MeV level. A weak resonance was observed at 1501 keV. (Sweden)

29952 ISOBARIC ANALOGUE STATES IN (p,n) REACTIONS AT 94 MeV. Langsford, A. (Atomic Energy Research Establishment, Harwell, Eng.); Bowen, P. H.; Cox, G. C.; Saltmarsh, M. J. M. Nucl. Phys., A113: 433-47(1968).

Targets of natural Al, Sc, V, Mn, Co, Cu, Nb, Ag, In, La, Ta, Au, Pb, and U were bombarded with 94-MeV protons. The neutron energy spectrum from each target was analyzed using a time-of-flight spectrometer with a 0.066 ns·m^{-1} resolution. Neutron energy resolution close to 90 MeV was ≈2 MeV (fwhm). Peaks were observed in the neutron spectra at energies corresponding to the formation of the isobaric analogs of the ground state of the parent nuclei. The angular distributions for these reactions were measured over the angular range 0 to 10°, and the relative cross sections determined in this experiment were normalized to the absolute production cross section of neutrons in the forward direction for the d(p,n)2p reaction. A limited analysis of the angular distributions in terms of the optical model indicates an isospin-dependent potential somewhat peaked on the surface and having a strength of 40 MeV at 94 MeV. This potential strength is lower than that similarly calculated for protons around 20 MeV and indicates that this potential is energy dependent. (auth)

29953 LEVEL STRUCTURE OF ^{43}Sc. Broman, L. (Chalmers Univ. of Tech., Goteborg). Ark. Fys., 35: 371-91(1968).

The ^{42}Ca(^{3}He,d)^{43}Sc reactions were studied at 16.5 MeV ^{3}He particle energy at two angles. Forty-nine deuteron groups leading to excited states in ^{43}Sc were detected, several of which were not reported earlier. A previously known low-lying doublet in ^{43}Sc at 846 and 878 keV has turned out to be a triplet with an additional level at 857 keV. A tentative $\frac{1}{2}^{+}$ assignment is given to a level at 3337 keV. The present experimental knowledge of the ^{43}Sc nucleus is discussed in the light of different models. (auth) (Sweden)

29954 LEVELS OF ^{60}Ni. Ballini, R.; Blair, A. G.; Cindro, N.; Delaunay, J.; Fouan, J. P. (Centre d'Etudes Nucleaires, Saclay, France). Nucl. Phys., A111: 147-76(1968).

The energy levels of ^{60}Ni were studied by proton inelastic scattering (E_p = 13 MeV) and the proton transfer reaction ^{59}Co(^{3}He,d) ($E_{^3He}$ = 18 and 22 MeV). In addition, the gamma rays following the decay of these levels (p, p′γ and ^{3}He, dγ) were investigated. The information obtained contains the following groups of data: the position of levels in ^{60}Ni excited by inelastic scattering of protons; the position of levels excited by the proton transfer reaction (^{3}He, d); the deformation parameters β_l and reduced transition probabilities G_l for some levels of the first group and the overlap factor C^2S for some of the second; the decay scheme of several levels of ^{60}Ni. In first approximation, strong states of the first group are collective states, while the strong states of the second are 1p-1h states containing the particular (one-particle, $f_{\frac{5}{2}}^{-1}$) component (the latter, assuming that ^{59}Co is a good $f_{\frac{7}{2}}$ proton hole in the ^{60}Ni core). The experimental energy of levels and transition rates are compared with the results of existing calculations. (auth)

29955 LOW-LYING EXCITED STATES OF ^{64}Cu AND ^{66}Cu POPULATED IN THERMAL-NEUTRON CAPTURE REACTIONS. Shera, E. B. (Los Alamos Scientific Lab., N. Mex.); Bolotin, H. H. Contract W-7405-eng-36. Phys. Rev., 169: 940-51 (May 20, 1968). (LA-DC-9227).

The level structures of the odd-odd nuclei ^{64}Cu and ^{66}Cu were studied by use of the thermal-neutron-capture reactions ^{63}Cu(n,γ)^{64}Cu and ^{65}Cu(n,γ)^{66}Cu. Capture γ-ray spectra from isotopically separated targets were studied in the approximate energy intervals 100 to 1500 keV and 5000 to 8000 keV with a Li-drifted Ge spectrometer system. A number of new transitions are reported. The levels obtained from these data are compared with those excited by the corresponding (d,p) reactions. γ-γ coincidence measurements with Ge(Li) and NaI detectors have also provided considerable information about the low-lying level structures of these nuclei. Tentative spin assignments for the excited states below 1 MeV are proposed on the basis of the γ-ray decay modes of these levels. The low-lying excited states of ^{64}Cu and ^{66}Cu are discussed in terms of $p_{\frac{3}{2}}$, $f_{\frac{5}{2}}$, and $p_{\frac{1}{2}}$ proton-neutron configurations. (auth)

29956 MEASUREMENT OF TOTAL DECAY ENERGIES. Rudstam, Goesta; Kjelberg, Arve (CERN, Geneva). Ark. Fys., 36: 107-10(1967).

From International Symposium on Why and How Should We Investigate Nuclides Far Off the Stability Line, Lysekil, Sweden. See CONF-660817.

Systematic studies of the total decay energy of nuclides far off stability are of great interest because they will provide information on the behavior of the energy surface away from the stable region. As part of the preparations for the ISOLDE project, the Nuclear Chemistry Group at CERN has therefore constructed an instrument suitable for Q-value determinations. It is at present operated off-line, but will be attached to the collector end of the isotope separator to be placed on-line with the CERN 600 MeV synchro-cyclotron. (auth)

29957 NUCLEAR DATA SHEETS. Nucl. Data, Sect. B, 2: B2,3,1-B2,3,108(Oct. 1967).

Experimental data, adopted values, comparisons with theory, and arguments for spin and parity assignments are given for energy levels and decay schemes for nuclei with A = 62, 63, and 64. (S.F.L.)

29958 NUCLEAR DATA SHEETS. Nucl. Data, Sect. B, 2: B2,5,1-2,5,123(Mar. 1968).

A compilation of information on the decay schemes and the level parameters and schemes of A = 59, 60, and 61 nuclei is presented. The techniques that were used to investigate the various levels are indicated; reaction parameters are included. In addition, a corrected drawing for the decay scheme of ^{148}Eu is presented in which the log-ft values that were omitted in the original publication are included. (D.C.W.)

29959 NUCLEAR MAGNETIC MOMENTS OF ^{60}Cu AND ^{62}Cu: hfs EXPERIMENT AND CONFIGURATION-MIXING CALCULATION. Phillips, E. A.; Jackson, A. D. Jr. (Princeton Univ., N. J.). Phys. Rev., 169: 917-23(May 20, 1968). (PUC-937-271).

The hyperfine structures of 24-min ^{60}Cu and 10-min ^{62}Cu were measured by the atomic-beam magnetic-resonance method. The results are: ^{60}Cu (I = 2), $\Delta\nu$ = 6033 (4) Mc/sec, μ_I = +1.219 (3) nm (diamagnetically corrected); ^{62}Cu (I = 1), $\Delta\nu$ = −2257.2 (5) Mc/sec, μ_I = −0.380 (4) nm. The spins were previously known. Configuration-mixing calculations in the $1f_{\frac{5}{2}}$-2p shell reproduce fairly well the spectra and binding energies of ^{58}Cu, ^{60}Cu, and ^{62}Cu, as well as these moments. (auth)

29960 NUCLEAR RESONANCE FLUORESCENCE IN ^{69}Ga. Langhoff, H.; Frevert, L. (Univ., Goettingen, Ger.). Nucl. Phys., A111: 225-35(1968).

Resonance fluorescence from the levels at 1107, 872, and 574 keV in ^{69}Ga was observed using gaseous sources of $^{69}GeCl_4$ and $^{69}GeBr_4$. The lifetimes obtained from resonance scattering and self-absorption experiments are $(g_0\tau/g_1)_{1107}$ = 0.16 ± 0.02 psec, $(g_0\tau/g_1)_{872}$ = 0.31 ± 0.06 psec and $(g_0\tau/g_1)_{574}$ = 5 ± 2 psec. The angular distribution of the resonantly scattered radiation is compatible only with spins $\frac{3}{2}$ and $\frac{5}{2}$ for the 1107 and the 872 keV levels and $|\delta| < 0.55$ for the corresponding E2−M1 transitions. Resonance scattering was also observed with solid $GeCl_4$ sources. This yields information on the slowing down of the recoiling nuclei. The investigation of the γ-spectrum emitted after the decay of ^{69}Ge using a Ge(Li) detector revealed seven new γ-transitions in addition to the 19 known γ-transitions. (auth)

29961 PARITY OF THE EXCITED LEVEL AT 3.786 keV IN ^{30}Si. Gorodetzky, Serge; Knipper, Albert; Merdinger, Jean-Claude; Schulz, Norbert (Institut de Recherches Nucleaires,

Strasbourg). Compt. Rend., Ser. A and B, 266: 512-13(Feb. 19, 1968). (In French).

An upper limit of the half-life of the excited level at 3786 keV of ^{30}Si suggests a positive parity for this level. (tr-auth)

29962 RELATION BETWEEN FINE AND INTERMEDIATE STRUCTURE IN THE SCATTERING OF NEUTRONS BY Fe. Monahan, J. E.; Elwyn, A. J. (Argonne National Lab., Ill.). Phys. Rev. Lett., 20: 1119-22(May 13, 1968.

An investigation of the fine structure in the region of an intermediate resonance observed at $E_n \approx 0.36$ MeV in the scattering of neutrons from Fe reveals properties consistent with the interpretation of this resonance as a doorway state in the compound nucleus. (auth)

29963 REACTION ^{36}S(p,γ)^{37}Cl AND PROPERTIES OF ^{37}Cl. Hyder, A. K. Jr. (Aerospace Research Lab., Wright-Patterson AFB, Ohio); Harris, Gale I.; Perrizo, J. J.; Kendziorski, F. R. Phys. Rev., 169: 899-910(May 20, 1968).

The reaction, ^{36}S(p,γ)^{37}Cl, was studied in the range E_p = 800 to 1940 keV in order to determine properties of excited states of ^{37}Cl. Over 80 narrow resonances due to this reaction were identified and located in proton energy with an accuracy of ±3 keV. The observed resonance strengths $(2J_r + 1)\Gamma_\gamma\Gamma_p/\Gamma$ vary between 0.1 and 6.3 eV, with the exception of the outstanding resonance at 1887 ± 2 keV, which has a strength of 130 ± 20 eV. The general behavior of the average resonance strength as a function of proton energy is in agreement with predictions based upon well-known approximate relationships between the level density and the radiative and proton widths Γ_γ and Γ_p. Detailed studies of the γ-ray decay schemes of resonances at E_p = 940, 969 (doublet), 983, 1079, and 1120 keV with large NaI(Tl) and Ge(Li) detectors provide evidence for previously unreported levels in ^{37}Cl at E_x = 3.62, 3.74, and (4.4) MeV. All of the new bound levels decay to the ground state. No evidence was found for a possible level in ^{37}Cl near 0.8 MeV. Spin assignments for each of the resonances listed above were derived from γ-ray angular-correlation measurements. The 1887-keV resonance (E_x = 10.22 MeV) decays predominantly to the 3.105-MeV level. The resonance and 3.105-MeV levels are each shown to have $J^\pi = \frac{1}{2}^-$ and to exhibit other expected properties of the T = $\frac{1}{2}$ and T = $\frac{3}{2}$ members of the $1f_{\frac{1}{2}}$ single-nucleon configuration. The resonance is identified as the analog of the ^{37}S ground state. The 3.105($\frac{1}{2}^-$) → ($\frac{3}{2}^+$) transition is mixed E3-M2 with δ = −0.18 ± 0.01. The resonance → 3.105 transition is pure M1 with an observed strength of 1.7 ± 0.3 Weisskopf units, in excellent agreement with a calculated value of 1.6 Weisskopf units for a ($1f_{\frac{1}{2}}$, T = $\frac{3}{2}$) → ($1f_{\frac{1}{2}}$, T = $\frac{1}{2}$) transition. A ^{36}S(p,γ)^{37}Cl reaction Q-value of 8.382 ± 0.008 MeV was determined from Ge(Li) spectra. (auth)

29964 REACTIONS ^{58}Ni(^{3}He,^{3}He′) AND ^{58}Ni(^{3}He,α) AT 51.3 MeV. Bingham, C. R.; Halbert, M. L. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. Phys. Rev., 169: 933-9 (May 20, 1968). (ORNL-P-3501).

Differential cross sections were measured for elastic and inelastic scattering of 51.3-MeV ^{3}He from ^{58}Ni, and for ^{58}Ni(^{3}He,α). The elastic scattering was analyzed in terms of the optical model with a Woods-Saxon potential. Several satisfactory sets of parameters were obtained. The inclusion of a spin-orbit term with $V_s \approx$ 2.9 MeV improved the best fits. The inelastic scattering events were treated as one-phonon collective transitions in the distorted-wave approximation, using complex coupling. The $\beta R_0'$ agreed well with deformation lengths from other experiments. No improvement in the fit to the 2^+ angular distribution was found in calculations with unequal real and imaginary deformations. The (^{3}He,α) results were compared with zero-range distorted-wave predictions, using a previously obtained empirical normalization. The spectroscopic factors are in good agreement with other experiments and sum-rule expectations. (auth)

29965 STUDY OF GAMMA RAYS FROM THE ^{43}Ca(p,p′γ)^{43}Ca REACTION AND THE DECAY OF ^{43}K AND ^{43}Sc. Chasman, C.; Jones, K. W.; Ristinen, R. A. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 169: 911-16(May 20, 1968). (BNL-11994).

A study was made of the γ-ray spectra produced in the proton bombardment of ^{43}Ca at proton energies of 2.550, 3.235, and 3.605 MeV. γ-ray branching ratios and excitation energies were determined for most states in ^{43}Ca previously seen in decay-scheme and reaction studies up to an excitation energy of 2.25 MeV. An examination of the γ-ray spectrum following the radioactive decay of ^{43}Sc shows that the log ft value for a transition to a possible $\frac{5}{2}^-$ state below 1.5 MeV in ^{43}Ca is greater than 5.7. Examination of the decay of ^{43}K shows some discrepancies with previous work. (auth)

29966 STUDY OF ^{30}P LEVELS BELOW 5 MeV. Vermette, C. W.; Olsen, W. C.; Hutcheon, D. A.; Sykes, D. H. (Univ. of Alberta, Edmonton). Nucl. Phys., A111: 39-62(1968).

Spins of 16 excited states of ^{30}P were investigated in conjunction with multipole mixing and branching ratios of a number of gamma transitions via the reaction ^{28}Si(^{3}He, pγ)^{30}P. Spin assignments are consistent with those of other investigators in all cases except for the 4.921 MeV level whose branching ratios are also in disagreement with those previously reported. Assuming, as suggested by the present results, a transition from the 4.921 MeV level to the 0.680 MeV level rather than to the 0.709 MeV level, a unique assignment of J = 1 is made to the 4.921 MeV level. A new probable assignment of J = 1 was made to the 3.736 MeV level. The previously unstudied 2.839, 3.836, 3.928, and 4.734 MeV levels were assigned possible spin values together with branching ratios and multipole mixing ratios for their decay transitions. Branching ratios for transitions from the 3.736, 3.836, 3.928, and 4.501 MeV levels are in serious disagreement with those of previous studies. Using shell-model wave functions, calculations of lifetimes, multipole mixing ratios and branching ratios corresponding to five low-lying states showed agreement with experimental values for only the first two excited states. (auth)

29967 STUDY OF ^{41}Sc LEVELS BY THE ^{40}Ca(p,γ)^{41}Sc REACTION. Youngblood, D. H.; Wildenthal, B. H.; Class, C. M. (Rice Univ., Houston, Tex.). Phys. Rev., 169: 859-77(May 20, 1968).

The level structure of ^{41}Sc produced in the ^{40}Ca(p,γ)^{41}Sc reaction was studied by measuring the positron activity [$E_{max}(\beta^+)$ = 5.5 MeV, $\tau_{\frac{1}{2}}$ = 0.6 sec] of the product nucleus. The measurements covered the range 0.6 ≤ E_p ≤ 5.2 MeV with a resolution width of about 5 keV. Forty-six resonances in the yield function were identified with states of ^{41}Sc. Absolute yields were also measured for each resonance with a β detector of calibrated efficiency. Since all excited states of ^{41}Sc are proton-unstable, these yields were attributed to transitions from the capture levels directly to the ground state. On this basis, and by assuming $\Gamma_\gamma < \Gamma_p$, values of the quantity $g\Gamma_{\gamma g.s.}$ were determined for the ground-state transition from each level. By evaluating the statistical factor g for various assumed values of the spin J, the radiative widths Γ_γ were obtained. When expressed in Weisskopf single-particle units, these values fell within the ranges expected for E1, M1 + E2, and E2 transitions. Since the ground-state spin of ^{41}Sc is $\frac{7}{2}^-$, these results eliminated from consideration assignments of $J^\pi = \frac{1}{2}^+, \frac{1}{2}^-$, and $\frac{3}{2}^+$ for the radiating states. For 16 of the most strongly excited levels, specific evidence with respect to possible values of J^π was obtained by measuring the angular distribution of the γ radiation emitted in transitions to the ground state. For ten additional states, earlier studies of proton elastic scattering furnished values of the orbital angular momentum l_p of the captured protons. These data permitted specific J^π assignments in 14 favorable cases, and restricted assignments to two values of J and either parity in ten cases. Eleven transitions are found to occur by means of either pure E2 or mixed M1 and E2 radiation. The combined strength of these transitions exhausts 6 to 8% of the E2 sum-rule limit. The present status of information on energies and values of J^π of the states of ^{41}Sc occurring at excitation energies up to 6.2 MeV is summarized. (auth)

29968 STUDY OF ^{46}Ti BY THE ^{45}Sc(^{3}He,d)^{46}Ti AND ^{46}Ti(p,p′)^{46}Ti REACTIONS. Barnard, R. W.; Jones, G. D. (Univ. of Colorado, Boulder). Nucl. Phys., A111: 17-38(1968). (COO-535-579).

Angular distributions to the ground state and six excited states of ^{46}Ti were measured for the ^{45}Sc(^{3}He, d)^{46}Ti reaction at a bombarding energy of 37.7 MeV. Also obtained is a ^{45}Sc(^{3}He, ^{3}He)^{45}Sc elastic angular distribution at the same energy. The angular distributions have shapes characteristic of a proton angular momentum transfer of 3, corresponding to stripping to the $1f_{\frac{7}{2}}$ nuclear shell. Some of the excited states also have admixtures of l_p = 1 components, corresponding to proton stripping to the $2p_{\frac{3}{2}}$ shell. The ^{46}Ti(p,p′)^{46}Ti data are analyzed in terms of simple shell-model configurations implied by the l_p transfers of the (^{3}He, d) work with configurations attainable by inelastic shell-model transitions. (auth)

29969 STUDY OF THE HALF-LIVES OF SHORT-LIVED NEUTRON-RICH ARSENIC ISOTOPES. del Marmol, P. (Centre d'Etude de l'Energie Nucleaire, Mol, Belgium). Ark. Fys., 36: 205-9(1967).

From International Symposium on Why and How Should We Investigate Nuclides Far Off the Stability Line, Lysekil, Sweden. See CONF-660817.

Determinations of the half-lives of neutron-rich As isotopes using chemical separations are described. Delayed neutron counting showed that for ^{87}As, $t_{\frac{1}{2}} \leq 1.5$ s and that for ^{85}As, $t_{\frac{1}{2}}$ = 2.15 ± 0.15 s. By milking off the Br grand-daughter products, preliminary results give for ^{83}As, $t_{\frac{1}{2}}$ = 10 ± 3 s and for ^{84}As, $t_{\frac{1}{2}} \approx$ 1 s. Other possibilities based on chemical separations are discussed. (auth)

29970 TEST OF TIME-REVERSAL INVARIANCE THROUGH THE REACTIONS ^{24}Mg + α ⇌ ^{27}Al + p. Von Witsch, W.; Rich-

ter, A.; von Brentano, P. (Max-Planck-Institut fuer Kernphysik, Heidelberg). Phys. Rev., 169: 923-32(May 20, 1968).

Time-reversal invariance was tested via detailed balance in the compound nuclear reactions $^{24}Mg + \alpha \rightleftharpoons {}^{27}Al + p$. The relative differential cross sections agree within the experimental uncertainties. An upper limit for the ratio of the T-nonconserving to the T-conserving part of the reaction amplitude was found to be 2 to 3×10^{-3}. A model-dependent upper limit between 4×10^{-4} and 3×10^{-3} was derived for the relative strength of the T-odd part of the nuclear Hamiltonian. (auth)

29971 THE $^{48}Ca(d,n)^{49}Sc$ REACTION AT E_d = 5.5 AND 6.0 MeV. Grandy, T. B.; McDonald, W. J.; Dawson, W. K.; Neilson, G. C. (Univ. of Alberta, Edmonton, Can.). Nucl. Phys., A113: 353-66(1968).

Transitions to states in ^{49}Sc were studied with the $^{48}Ca(d,n)^{49}Sc$ reaction at E_d = 5.5 and 6.0 MeV. At E_d = 5.5 MeV, angular distributions were measured for a number of states up to 7-MeV excitation energy. The isobaric-analog of the ^{49}Ca ground state was identified at an excitation energy of 11.571 ± 0.009 MeV. Excitation energies for levels in ^{49}Sc have been found to be somewhat lower than those found in previous measurements. However, l-values and spectroscopic factors are shown to be in good agreement with previously measured values from the $^{48}Ca(^3He,d)^{49}Sc$ reaction. (auth)

29972 THE $^{42,44}Ca(p,d)^{41,43}Ca$ REACTIONS AT 26.5 MeV. Smith, S. M. (Massachusetts Inst. of Tech., Cambridge); Bernstein, A. M.; Rickey, M. E. Contract AT(30-1)-2098. Nucl. Phys., A113: 303-31(1968). (MIT-2098-426).

The $^{42}Ca(p,d)^{41}Ca$ and $^{44}Ca(p,d)^{43}Ca$ reactions at 26.5 MeV were examined with 100-keV resolution to obtain nuclear structure information on the levels observed in ^{41}Ca and ^{43}Ca up to an excitation energy of approximately 8 MeV and on the ground-state wave functions of ^{42}Ca and ^{44}Ca. The strong $2s_{\frac{1}{2}}$ and $1d_{\frac{3}{2}}$ hole states were verified at 2.68 and 2.02 MeV, respectively, in ^{41}Ca and at 1.96 and 0.99 MeV, respectively, in ^{43}Ca. Isobaric analog states ($T = T_z + 1$) were located at 5.84 ± 0.05 MeV ($J^\pi = \frac{3}{2}^+$), 6.82 ± 0.05 MeV ($\frac{1}{2}^+$) and 7.13 ± 0.05 MeV ($\frac{7}{2}^-$) in ^{41}Ca and 7.97 ± 0.05 MeV ($\frac{1}{2}^+$) in ^{43}Ca. The presence of additional levels in both nuclei with $l_n = 0$ and $l_n = 2$ transitions implies that the one-hole state strength is distributed over several levels. Evidence for the splitting of the $1f_{\frac{7}{2}}$ single-particle strength was found with the excitation of states with $l_n = 3$ transitions at 2.98 and 3.28 MeV in ^{41}Ca and ^{43}Ca, respectively, whose spectroscopic strengths are approximately 11% and 7.5%, respectively, of the corresponding ground-state transitions. Excitation of the 7.13 MeV ($\frac{7}{2}^-$, $T = \frac{3}{2}$) level in ^{41}Ca indicates the presence of four-particle-two-hole components in the ^{42}Ca ground state. Using sum rules, the average number of $1f_{\frac{7}{2}}$ protons in the ^{42}Ca ground state was found to be approximately 0.6. The different relative spectroscopic strengths for the (p,d) and (d,p) reactions leading to $\frac{3}{2}^-$ states in ^{43}Ca at 0.59 and 2.05 MeV demonstrate that both $[(1f_{\frac{7}{2}})^2(2p_{\frac{3}{2}})^2]$ and $[(1f_{\frac{7}{2}})^3(2p_{\frac{3}{2}})]$ admixtures are present in the ^{44}Ca ground state. Indication of an $[(1f_{\frac{7}{2}})^3(1f_{\frac{5}{2}})]$ admixture is also found from the excitation of the $\frac{5}{2}^-$ state at 0.373 MeV in ^{43}Ca. A nonpick-up angular distribution to the 1.68-MeV level in ^{43}Ca was observed. If the previously made tentative assignment of $1\frac{1}{2}^-$ for this state is correct, this transition proceeds by higher-order reaction mechanisms. The spectroscopic strengths for the levels excited were derived from DWBA calculations using form factors modified by finite-range and nonlocal corrections in the local-energy approximation. The resulting shapes of the angular distributions were in better agreement with the experimental results than those for zero-range local calculations; the derived spectroscopic strengths were also less sensitive to the choice of optical potential parameters and in better agreement with sum-rule predictions. Comparisons between the experimental spectroscopic strengths and those predicted by theoretical wave functions are made where such wave functions are known. (auth)

29973 THE (n,2n) REACTION CROSS SECTION OF ^{31}P, ^{64}Zn, ^{69}Ga, AND ^{107}Ag FOR 14.8-MeV NEUTRONS. Mitra, B. (Bose Inst., Calcutta). Indian J. Phys., 41: 752-8(Oct. 1967).

The (n,2n) cross sections for 14.8-MeV neutrons were measured, relative to the ^{63}Cu cross section, for four nuclei by activation analysis method. The results were compared with values calculated from the evaporation model of the compound nucleus. Significant disagreement of values of nuclear temperature was obtained in some cases. (auth)

29974 THE (n,γα) REACTION INDUCED BY THERMAL NEUTRONS. Oakey, N. S.; MacFarlane, R. D. (McMaster Univ., Hamilton, Can.). Phys. Lett., 26B: 662-3(Apr. 29, 1968).

The thermal neutron (n,γα) reaction was detected for the first time. Alpha transitions were observed from levels in ^{144}Nd at 1 to 2 MeV below the thermal neutron capture state, in addition to transitions from the capture state to low-lying levels of ^{140}Ce. (auth)

29975 ELASTIC SCATTERING OF POLARIZED DEUTERONS FROM ALUMINUM, SILICON, AND NICKEL. Schwandt, Peter. Madison, Wis., Univ. of Wisconsin, 1967. 185p.

Thesis.

Polarization parameters were measured for 7 to 11 MeV deuteron elastic scattering from ^{27}Al, ^{28}Si, and ^{60}Ni at laboratory angles between 30° and 135°. The vector polarization iT_{11} and two tensor parameters T_{20} and T_{22} were obtained from measurements of the polarized-to-unpolarized cross-section ratio in the scattering of polarized and unpolarized deuteron beams obtained from the Wisconsin tandem accelerator. The angular distributions of these polarization parameters show more or less pronounced oscillations about zero, with amplitudes generally increasing towards backward angles. In all cases the vector polarization was found to be larger than the tensor polarizations, with substantially larger effects observed for Al and Si than for Ni. The largest value of vector polarization iT_{11} found was −0.28 for Al, 11 MeV around 90°, compared to −0.13 for Ni, 11 MeV around 130°. The maximum observed tensor polarization T_{20} was +0.2 for Al and Si near 120°. The energy dependence of the polarizations was much less pronounced for the lighter elements than for Ni. For Al and Si, angular distributions of the unpolarized cross-section were also measured. An optical model analysis of the polarization and cross-section data was performed to obtain information about the various spin-dependent terms in the optical potential. The analysis showed that the deuteron vector polarization is described reasonably well by a vector spin-orbit coupling of about the same strength as found for nucleon scattering, while a tensor potential of some kind appears to be necessary to account for the observed tensor polarizations. (Diss. Abstr.)

29976 LIFETIMES OF GAMMA-RAY TRANSITIONS IN THE S-D SHELL BY THE DELAYED COINCIDENCE METHOD. Mendelson, Robert Alexander Jr. Iowa City, Iowa, Univ. of Iowa, 1967. 95p.

Thesis.

Lifetimes of the low-lying states of various nuclei in the 2s-1d shell were measured by the delayed coincidence technique. Time differences between the detection of a charged particle indicating formation of a state and the detection of the decay gamma ray were determined. The particle detection was accomplished by a solid-state detector with time pickoff and charge sensitive preamplifier. Gamma rays were detected by various scintillators mounted on a fast photomultiplier. The 0.278- and 1.10-MeV states of ^{21}F were generated by the reaction $^{18}O(^7Li,\alpha)^{21}F$, the ^{15}C state 0.750-MeV by $^9Be(^7Li,p)^{15}C$, the ^{24}Na 0.560-MeV state by $^{23}Na(d,p)^{24}Na$, and the ^{32}P 0.077-MeV state by $^{31}P(d,p)^{32}P$. The ^{21}F result implies an E2 transition for the 278-keV level and thus a $\frac{1}{2}^+$ assignment for the spin which agrees with (t,p) stripping results. This implied level ordering was explained on the basis of a band mixed collective model with a reduced deformation for ^{21}F compared to ^{19}F. The ^{15}C result agreed with earlier work using the reaction $^{14}C(d,p)^{15}C$. For ^{24}Na the upper limit was somewhat lower and less ambiguous set in earlier work by bombarding sodium iodide with neutrons. The lifetime of the 77-keV level in ^{32}P does not agree with the predictions of pure j-j coupling. (Diss. Abstr.)

29977 NUCLEAR TABLES. PART II. NUCLEAR REACTIONS. Volume 3. THE ELEMENTS FROM CHLORINE TO CALCIUM. Kunz, Wunibald; Schintlmeister, Josef. Oxford, Pergamon Press Ltd., 1968. 216p. $50.00.

Includes tables.

A compilation of data for nuclear reactions on the elements Ar, Ca, Cl, and K and on specific isotopes of these elements is presented. Q-values for the compilation were calculated using the 1964 mass table of Mattauch et al. (Nucl. Phys., 67: 1-31(1965)). Information on the level schemes of specific isotopes is also included. (D.C.W.)

29978 THE (n,d) REACTION IN SULFUR ISOTOPES AT 14.1 MeV. Wagner, Robert Richard. Providence, R. I., Brown Univ., 1967. 75p.

Thesis.

Thin targets enriched in ^{32}S and ^{34}S were bombarded by 14.1-MeV neutrons, and the emergent deuterons studied with a telescope consisting of two dE/dx proportional counters and a CsI energy detector. Deuterons in the range 2.0 to 8.0 MeV were distinguished from other charged particles by means of the known dE/dx vs energy relations, using a pulse multiplier particle discrimination system. In $^{32}S(n,d)^{31}P$ transitions were observed to states at E_x = 0, 1.27, and 2.23 MeV in ^{31}P, and the angular distributions measured over the range 0 to 40°. No substantial evidence was seen for a transition to a state near E_x = 0.5 MeV. The yield and angular distributions for the ground state transi-

tion confirmed earlier measurements and were analyzed by means of the Butler and DWBA stripping theories. The angular distributions for the excited-state transitions do not display the usual direct interaction form, but suggest the combined effects of stripping and knock-out or spin-flip interactions. In $^{34}S(n,d)^{33}P$, the ground-state transition yield and angular distribution were measured over the range 0 to 30° and interpreted in terms of the Butler and DWBA theories. Some evidence was seen for a transition to a previously unobserved excited state near 1.6 MeV. (Diss. Abstr.)

Nuclear Properties and Reactions, A ≥ 90

Refer also to abstracts 27625, 27836, 28097, 28148, 28153, 29804, 29844, 29940, 29949, 29952, 29973, 30048, 30063, 30065, 30067, 30068, 30072, 30089, 30090, 30098, 30100, 30102, and 30110.

29979 (BARC-318) ANGULAR ANISOTROPY OF FISSION FRAGMENTS IN TERNARY FISSION OF ^{235}U INDUCED BY 3-MeV NEUTRONS. Nadkarni, D. M. (Bhabha Atomic Research Centre, Bombay (India)). 1967. 35p. Dep.

The values of angular anisotropy of fragments in binary and ternary fission of ^{235}U induced by 3-MeV neutrons were determined by two independent methods. In the first method fission fragments and long-range alpha particles were detected with a gridded ionization chamber and a CsI crystal respectively and in the second method semiconductor detectors were used to detect fission fragment and long-range alpha particles. The values of $[N(0^0)/N(90^0)]$ for cases of binary and ternary fissions are found to be different. The probability for emission of long-range alpha particles in 3-MeV neutron induced fission is found to be lower than that in thermal neutron-induced fission. A decrease in the average single fragment kinetic energy of ternary fragments compared to that of binary fragments is observed in 3-MeV neutron-induced fission similar to that in thermal neutron fission. It is shown that on the basis of the angular distribution of long-range alpha particles and ternary fragments it is possible to learn at what stage in the fission process the long-range alpha particles are emitted. (auth)

29980 (IFA-N.S.-20) THE EXCITED LEVELS OF ^{193}Ir. Badica, T.; Gelberg, A.; Kemeny, P.; Salageanu, S.; Mihai, R. Ion (Academia R. P. R., Bucharest. Institutul de Fizica Atomica). 1968. 18p. Dep.

The levels of ^{193}Ir, populated by the radioactive decay of ^{193}Os, were studied by means of Ge(Li) and scintillation detectors. Single and coincidence spectra, as well as angular correlations, were measured; a level scheme of ^{193}Ir is proposed. (auth)

29981 (JINR-P6-3744) ISSLEDOVANIE REAKTSII (d,p) I (d,t), PRIVODYASHCHIKH K SPONTANNO DELYASHCHIMSYA IZOMERAM. (Investigation of the Reactions (d,p) and (d,t) Leading to the Spontaneously Fissionable Isomers). Bjoernholm, S.; Borggreen, J.; Gangrskii, Yu. P.; Sletten, G. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1968. 10p. (In Russian). Dep.

The reactions (d, p) and (d, t), leading to the spontaneously fissionable ^{240}Am, ^{242}Am, and ^{244}Am isomers were investigated in the energy range of 9 to 13 MeV. The measurement of the (d, p) and (d, t) reactions cross sections has shown that the isomeric ratio in these reactions is rather small as compared to that of the reactions (d, 2n), which lead to the production of the same nuclei. The difference in isomeric ratios can not be explained by the difference in distributions according to the excitation energies and the spin of the Am nuclei remaining after the particle emission. (auth)

29982 (JINR-P7-3766) 103-i ELEMENT PERIODICHESKOI SISTEMY. (Element 103 of the Periodic System). Donets, E. D.; Druin, V. A.; Mikheev, V. L. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1968. 22p. (In Russian). Dep.

Results of work on the synthesis and studies of the properties of Element 103 isotopes are analyzed. It was concluded that the most reliable and complete data were obtained for the isotope $^{256}103$. The half-life of this isotope is about 35 sec and its alpha emission spectrum is complicated and lies between 8.3 and 8.5 MeV. To get the same degree of unambiguity in determining the properties of other isotopes of element 103, in particular of $^{257}103$, some additional experiments are needed. (auth)

29983 (MIT-905-108, pp 1-32) NUCLEAR CHEMISTRY GROUP. (Massachusetts Inst. of Tech., Cambridge. Lab. for Nuclear Science).

Results are reported for decay studies on ^{71}Zn, ^{72}Zn, ^{111}Ag, ^{113}Ag, ^{113}Te, ^{115}Ag, ^{123}I, ^{124}Sb, ^{129}Te, ^{131}Te, ^{133}Sb, ^{135}I, and ^{135}Xe. Energy levels and transitions were determined for ^{71}Ga, ^{72}Ga, ^{88}Sr, ^{111}Cd, ^{113}Cd, ^{115}Cd, ^{117}Sn, ^{129}Te, ^{129}I, ^{131}I, ^{135}Cs, and ^{135}Xe. (S.F.L.)

29984 (ORNL-4252) ELASTIC AND INELASTIC SCATTERING OF PROTONS FROM ^{120}Sn FOR E_p = 20.6, 25.2, 30.6, AND 36.2 MeV: TABULATED DIFFERENTIAL CROSS SECTIONS. Bertrand, F. E.; Love, T. A.; Baron, N.; Perey, F. G.; Dickens, J. K. (Oak Ridge National Lab., Tenn.). May 1968. Contract W-7405-eng-26. 13p. Dep. CFSTI.

Numerical values of differential cross sections for elastic and inelastic scattering of protons from ^{120}Sn for bombarding proton energies of 20.6, 25.2, 30.6, and 36.2 MeV are reported in tabular form. Inelastic scattering data are reported for the 1.17-MeV (2^+) state at all incident energies, and for the 2.35-MeV (3^-) state at 20.6-, 25.2-, and 36.2-MeV incident energies. Cross sections were obtained at ~5° intervals between laboratory angles of 15 and 110°. (auth)

29985 (ORNL-TM-2121) COULOMB EXCITATION STUDIES OF ^{104}Pd, $^{106\ 108}Cd$, $^{182\ 184\ 186}W$, $^{188\ 189\ 190\ 192}Os$, AND $^{192\ 194\ 196\ 198}Pt$. Milner, William Thomas (Oak Ridge National Lab., Tenn.). May 1968. Contract W-7405-eng-26. 208p. Dep. CFSTI.

Thesis. Submitted to Univ. of Tennessee, Knoxville.

The low-lying states of some even-even nuclei in the slightly deformed (vibrational) region and the highly deformed (rotational) region were investigated using Coulomb excitation. Transition probabilities and branching ratios were determined. The results were compared with predictions of the asymmetric rotator model, the vibrational model, and the pairing-plus-quadrupole model. (D.C.W.)

29986 (ORNL-TM-2140) MEASUREMENT OF THE NEUTRON FISSION AND CAPTURE CROSS SECTIONS FOR ^{233}U IN THE ENERGY REGION 0.4 TO 2000 eV. Weston, L. W.; Gwin, R.; deSaussure, G. (Oak Ridge National Lab., Tenn.); Fullwood, R. R.; Hockenbury, R. W. (Rensselaer Polytechnic Inst., Troy, N. Y.). Apr. 8, 1968. Contracts W-7405-eng-26; AT(30-3)-328. 64p. Dep. CFSTI.

The neutron capture cross section and fission cross section for ^{233}U were measured simultaneously in the neutron energy range 0.4 to 2000 eV. A pulsed and collimated neutron beam was passed through a ^{233}U fission chamber placed at the center of a large liquid scintillator. Capture and fission events in the ^{233}U chamber were detected in the scintillator by means of their prompt gamma rays. Coincident signals from the fission chamber and liquid scintillator distinguished fission from capture events. Comparisons with previously published data, using similar and different methods, are given. (auth)

29987 (USNRDL-TR-68-25) IDENTIFICATION AND YIELD OF ^{117}Pd IN THE THERMAL-NEUTRON FISSION OF ^{235}U. Weiss, H. V.; Elzie, J. L.; Fresco, J. M. (Naval Radiological Defense Lab., San Francisco, Calif.). Feb. 12, 1968. 20p. Dep. CFSTI.

As part of a study of nuclear charge distribution in the region of symmetric fission, the existence and cumulative fission yield of ^{117}Pd were sought. Palladium was isolated free from silver and cadmium at different times after fission and the quantity of descendant ^{117}Cd activity produced was measured. A half-life for ^{117}Pd of 5.0 sec was derived from these data. Through a comparison of ^{117}Cd activity produced by ^{117}Pd with the total ^{117}Cd activity produced by all isobars, a cumulative fractional chain yield of 0.682 was computed for ^{117}Pd. From this yield the most probable nuclear charge (Z_p) for the 117-mass chain was estimated. (auth)

29988 (ANL-Trans-605) γ-RAY SPECTRA FROM THE RESONANCE NEUTRON CAPTURE IN Ba AND Pr. Bechvarzh, F.; Vrzal, Ya.; Liptak, Ya.; Urbanec, Ya. Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from report JINR-P3-3696. 22p. Dep. CFSTI, JCL $2.60 fs, $1.10 mf.

With the help of a high-resolution spectrometer the γ-ray spectra following neutron capture in ^{135}Ba and ^{141}Pr were measured. On the basis of the results obtained, conclusions have been drawn about the character of intensive primary transitions for the 24.5-eV resonance of ^{135}Ba and about the character of the resonances in ^{141}Pr as well. (auth)

29989 (ANL-Trans-604) γ-RAY SPECTRUM FROM THE RADIATIVE CAPTURE IN Cs. Bechvarzh, F.; Vrsal, Ya.; Liptak, Ya.; Urbanec, Ya. Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from report JINR-P3-3697. 10p. Dep. CFSTI, JCL $1.60 fs, $0.80 mf.

Measurements of the γ-ray spectra following resonance neutron capture in ^{133}Cs, performed with the aid of the Ge(Li) detector of active volume about 12 cm^3, are described. The energies and intensities of a number of transitions were obtained. (auth)

29990 ACCURATE DETERMINATION OF SOME RADIOACTIVE HALF-LIVES. Lagoutine, Frederic; Le Gallic, Yves; Legrand, Jean (CEN de Saclay, Gif-sur-Yvette, France). Int. J. Appl. Radiat. Isotop., 19: 475-82(May 1968).

For the accurate determination of the half-life of radionuclides, three methods were employed: differential ionization chambers, a proportional 4π beta counter, and a gamma scintillation spectrometer. The half-lives of the following radionuclides were determined: ^{24}Na, ^{54}Mn, ^{56}Mn, ^{60}Co, ^{90}Y, ^{95}Nb, ^{125}I, ^{131}I, ^{133}Ba, ^{144}Ce, ^{198}Au, ^{203}Hg, and ^{204}Tl. (auth) (UK)

29991 ACTIVITY OF THE FISSION PRODUCTS OF ^{235}U AND ^{239}Pu. de Tourreil, R. (Groupement Atomique Alsacienne Atlantique, France). J. Nucl. Energy, 22: 231-49(Apr. 1968).

The influence of the different properties of the fissile nuclide and its fission products on the fission-product activities and power output is tested. For this purpose the complete system of coupled differential equations is exactly solved taking into account the effect of the neutron capture cross sections of the fission products. A direct comparison is possible in the case of an "instantaneous fission." The influence of the nuclear charge distribution and of the fission products whose half-lives only are known is discussed in detail, so that the limit of validity of the calculations can be determined with precision. The activities and the β and γ power outputs from the fission products are then calculated for various irradiation and cooling times in the case of ^{235}U and ^{239}Pu. The influence of the neutron capture cross sections of the fission products is studied by varying the neutron flux. It is shown that up to a neutron flux of the order of 10^{14} n/cm^2/s the neutron capture cross sections of the fission products do not change their activities appreciably. (auth) (UK)

29992 AN ATTEMPT TO DETERMINE THE SPINS OF ^{235}U SLOW NEUTRON RESONANCES. Asghar, M.; Michaudon, A.; Paya, D. (CEA, Saclay, France). Phys. Lett., 26B: 664-5(Apr. 29, 1968).

The "γ-ray multiplicity method" was applied to low-energy resonances in ^{235}U. Appropriate biases were set to minimize the effect of fission γ rays. The data on 24 resonances fall into two groups which are assumed to correspond to the two different spin states. (auth)

29993 ANALOG STATES EXCITED WITH THE ^{93}Nb(p,d)^{92}Nb REACTION. Taketani, H.; Adachi, M.; Yoshida, Y.; Ogawa, M.; Ashibe, K. (Tokyo Inst. of Tech.). Phys. Lett., 26B: 660-1 (Apr. 29, 1968).

Excited states up to about 13 MeV in ^{92}Nb were investigated with the reaction ^{93}Nb(p,d)^{92}Nb. Two prominent l_n = levels at Ex = 11.54 11.80 MeV were found. These are attributed to the analogs of the possible 5^- and 4^- levels in ^{92}Zr. The sum of the transition strengths for these two states, in comparison with the $2p_{1/2}$ analog state pick-up strength in the reaction ^{90}Zr(p,d)^{89}Zr, implies that the percentage of the $(2p_{1/2})^2$ proton configuration in ^{93}Nb is 60 ± 12%. (auth)

29994 COMPARISON OF OBSERVED DELAYED-NEUTRON ABUNDANCES WITH CALCULATED FISSION YIELDS OF NEUTRON PRECURSORS. Patzelt, P.; Schuessler, H. D.; Herrmann, G. (Univ., Mainz). Ark. Fys., 36: 453-61(1967).

From International Symposium on Why and How Should We Investigate Nuclides Far Off the Stability Line, Lysekil, Sweden. See CONF-660817.

Neutron emission probabilities were derived for nuclei produced in various fission reactions. The computations were made for reactions in which experimental neutron abundances have been reported or for which the extrapolation of cumulative yields of the neutron precursors is feasible. Only the 55-, 22-, 6-, and 2-sec periods were considered. Experiments on the non-halogen contribution to delayed-neutron abundances were made and are reported. Comparisons of delayed-neutron abundances with calculated fission yields of halogen and non-halogen neutron precursors are made. (S.F.L.)

29995 COMPILATION OF DATA ON ALPHA ACTIVITIES WITH Z > 50, N < 126. Eskola, Pirkko (Univ. of Helsinki). Ark. Fys., 36: 477-94(1967).

From International Symposium on Why and How Should We Investigate Nuclides Far Off the Stability Line, Lysekil, Sweden. See CONF-660817.

The experimental data on alpha energies, half-lives, and branching ratios are presented in tables. An attempt was made to make the calibration energies of various measurements compatible. The experimental alpha-decay energies and those given by the 1964 atomic mass table and mass formulas are presented graphically as a function of the neutron number of the parent nucleus. (auth)

29996 CORE POLARIZATION AND QUASIPARTICLE THEORIES OF VIBRATIONAL NUCLEI WITH A REALISTIC NUCLEON-NUCLEON FORCE. Gmitro, M.; Hendekovic, J.; Sawicki, J. (International Centre for Theoretical Physics, Trieste, Italy). Phys. Rev., 169: 983-92(May 20, 1968).

Two- and four-quasiparticle Tamm-Dancoff theories are applied to study the even-parity states of the even tin isotopes. The residual nucleon-nucleon force is the realistic potential of Tabakin. The effects of the core neutrons and protons on the 0^+, 2^+, and 4^+ states are investigated by including the appropriate BCS and configuration-mixing contributions directly and by the "core polarization" renormalization of Bertsch, Kuo, and Brown. The core-polarization corrections are found to be most important and generally sufficient to explain the basic experimental data. The summation of the random-phase-approximation bubble and related exchange diagrams to all orders for the core nucleons gives almost the same results as those obtained with only second-order corrections. Such second-order corrections seem to be a sufficient approximation independently of the single-particle basis chosen. (auth)

29997 DETECTION OF LONG-RANGE FRAGMENTS FROM DECAY OF ^{252}Cf. Natowitz, Joseph B. (State Univ. of New York, Stony Brook); Khodai-Joopari, Arastoo; Alexander, John M.; Thomas, T. Darrah. Phys. Rev., 169: 993-9(May 20, 1968).

Long-range products from the decay of ^{252}Cf were observed by range discrimination and detection of tracks in mica and lexan. Integrated yields (events per binary fission) of $\gtrsim 18 \times 10^{-6}$ and kinetic energies of 1.5 to 4 MeV/amu are indicated for fragments of B, C, N, and O. Integrated yields of $\gtrsim 3 \times 10^{-6}$ and kinetic energies of 1.5 to 2.5 MeV/amu are indicated for fragments of oxygen or heavier nuclei. (auth)

29998 DETERMINATION OF THE TOTAL WIDTHS OF THE SINGLE-PARTICLE ANALOG RESONANCES IN ^{209}Bi. von Brentano, P.; Dawson, W. K.; Moore, C. F.; Richard, P.; Wharton, W.; Wieman, H. (Univ. of Washington, Seattle). Phys. Lett., 26B: 666-7(Apr. 29, 1968).

Proton inelastic scattering excitation functions to various final states in ^{208}Pb which resonate strongly at one analog resonance were fitted by a five parameters formula. For each of the seven observed single-particle analog resonance in ^{209}Bi consistent values for the total width. Γ, the resonance energy, E_0, were found. (auth)

29999 ENERGY LEVELS AND CONFIGURATIONS IN ^{94}Nb. Jurney, E. T. (Los Alamos Scientific Lab., N. Mex.); Motz, H. T.; Sheline, R. K.; Shera, E. B.; Vervier, Jean. Nucl. Phys., A111: 105-28(1968). (LA-DC-9240).

In the high-energy thermal neutron capture gamma-ray spectrum of ^{94}Nb, 83 gamma rays were observed between 4500 keV, and the neutron binding energy was determined to be 7229.5 ± 1.5 keV. A total of 71 low-energy gamma rays was observed from 30 keV to 1500 keV. These and previous data were used to develop a decay scheme. The presence of states arising predominantly from the following configurations is proposed: $\pi g_{9/2}\nu(d_{5/2})^2_3$, $\pi g_{9/2}\nu(d_{5/2})^2_4$, $\pi(p_{1/2})^{-1}(g_{9/2})^2_0\nu(d_{5/2})^2_2$ and, more tentatively, $\pi(p_{1/2})^{-1}(g_{9/2})^2_0\nu(d_{5/2})^2_4$ and $\pi g_{9/2}\nu(d_{5/2})^2_0 S_{1/2}$. Some preliminary assignments of spins and parities to other states were also attempted. Calculations based on ^{90}Zr and ^{88}Sr cores both agree well with energies, spectroscopic factors and reduced M1 transition probabilities. The generally close agreement between the calculations involving different cores is surprising in view of the considerable differences in the two sets of wave functions. This is probably to be understood in terms of the ability of the effective nucleon-nucleon interaction to absorb the effect of configuration mixing. (auth)

30000 EVAPORATION OF 3 TO 8 NEUTRONS IN REACTIONS BETWEEN ^{12}C AND VARIOUS URANIUM NUCLIDES. Sikkeland, Torbjorn; Maly, Jaromir; Lebeck, Donald F. (Univ. of California, Berkeley). Contract W-7405-eng-48. Phys. Rev., 169: 1000-6(May 20, 1968). (UCRL-17588(Rev.)).

Cross sections for the production of ^{242}Cf, ^{243}Cf, ^{244}Cf, ^{245}Cf, and ^{246}Cf in reactions between ^{12}C and ^{233}U, ^{234}U, ^{235}U, ^{236}U, and ^{238}U were measured in the energy range 60 to 110 MeV for ^{12}C. A good fit is obtained to the peaks of the cross-section curves. The fit involved calculation of the compound nucleus cross section by the use of the parabolic approximation to the real part of the optical model, modification of Jackson's formula for P_x to include fission and angular-momentum effects, and use of the Γ_n/Γ_f formula due to Fujimoto and Yamaguchi. The analysis suggests that the value of $\langle\Gamma_n/\Gamma_f\rangle_{av}$ is independent of the energy of ^{12}C. The formula by Fujimoto and Yamaguchi reproduces the experimental $\langle\Gamma_n/\Gamma_f\rangle_{av}$ values with a standard deviation of 16%. (auth)

30001 EXCITED STATES OF ^{93}Mo. Yen, A. (Haverford Coll., Pa.); Ajenberg-Selove, F.; Rosner, Baruch. Nucl. Phys., A111: 100-4(1968).

The reaction ^{92}Mo(d,p)^{93}Mo was studied using a broad-range spectrograph and 10.1 MeV deuterons from the University of Pennsylvania tandem accelerator. Two previously unreported states of ^{93}Mo were observed. (auth)

30002 EXPERIMENTAL AND THEORETICAL INVESTIGATION OF THE ^{208}Pb(p,t)^{206}Pb REACTION AT 40 MeV. Smith, S. M. (Massachusetts Inst. of Tech., Cambridge); Moazed, Cyrus; Bernstein, A. M.; Roos, P. G. Contract AT(30-1)-2098. Phys. Rev., 169: 951-4(May 20, 1968). (MIT-2098-399).

The reaction, ^{208}Pb(p,t)^{206}Pb, induced by 40-MeV protons was studied with 100-keV resolution. The shapes of the differential cross sections reproduce those predicted by distorted-wave Born-approximation calculations. The relative theoretical magnitudes of these cross sections for three different sets of ^{206}Pb wave functions are in reasonable agreement with the experimental results. The similarity between the predictions of these three sets of wave functions for the observed levels indicates that the predicted strengths are primarily sensitive to the relative signs of the wave-function components and not their exact magnitudes. The over-all agreement between theory and experiment for each set of wave functions would be somewhat improved if the theoretically predicted ground-state transition were enhanced relative to that of the excited states by approximately 40%. (auth)

30003 FAST NEUTRON EXCITATION OF ISOMERIC ACTIVITIES IN ^{112}In AND ^{114}In ISOTOPES. Kozlowski, T.; Moroz, Z.; Rurarz, E.; Wojtkowska, J. (Inst. of Nuclear Research, Swierk, Poland). Acta Phys. Pol., 33: 409-18(Mar. 1968).

The 14.7-MeV neutron cross sections were measured for ^{113}In (n, 2n) ^{112g,m}In and ^{115}In(n,2n) ^{114g,m}In reactions. Experimental results for isomeric ratios are compared with the statistical theory predictions. (auth)

30004 FINE STRUCTURE IN FISSION FRAGMENT CHARGE DISTRIBUTION. Konecny, E.; Gunther, H.; Siegert, G. (Justus Liebig-Univ., Giessen, Ger.). Ark. Fys., 36: 319-23(1967).

From International Symposium on Why and How Should We Investigate Nuclides Far Off the Stability Line, Lysekil, Sweden. See CONF-660817.

The primary nuclear charge distribution in mass separated fission fragments from ^{235}U thermal neutron induced fission was studied. Fine structure due to closed nuclear shells and nuclear pairing effects was observed in the nuclear charge distributions. (auth)

30005 FISSION CROSS-SECTION MEASUREMENT ON ^{235}U. Cao, M. G.; Migneco, E.; Theobald, J. P.; Wartena, J. A.; Winter, J. (EURATOM, Geel, Belg.). J. Nucl. Energy, 22: 211-30(Apr. 1968).

The cross section of the ^{235}U(n,f) reaction was measured with high-energy resolution for neutrons between 6 eV and 3 keV. A fission-fragment and a fission neutron detector were used simultaneously. Resonance parameters for 78 levels between 6 and 150 eV are given. The statistical distributions of Γ_f, Γ_γ and α were studied. (auth) (UK)

30006 GAMMA-RAY SPECTRA OF SHORT HALF-LIFE NUCLIDES BY HIGH RESOLUTION LID GERMANIUM DETECTOR. Chung, Moon Kyu; Suh, Doo Whan (Atomic Energy Research Inst., Seoul). J. Nucl. Sci. (Seoul), 7: No. 1, 82-5(Oct. 1967). (In Korean).

A collection of gamma-ray spectrograms is presented for nuclides with half-lives less than several minutes which were produced from natural elements by thermal neutron irradiation. These spectra were measured using a planar-type lithium ion-drifted germanium detector of 3-mm depletion depth. For comparison gamma-ray spectrograms taken by NaI(Tl) scintillation spectrometer are illustrated for each nuclide. (auth)

30007 IDENTIFICATION OF SHORT-LIVED ACTIVITIES PRODUCED IN HEAVY-ION REACTIONS. Alexander, Karl F. (Joint Inst. for Nuclear Research, Dubna, USSR). Ark. Fys., 36: 257-61(1967).

From International Symposium on Why and How Should We Investigate Nuclides Far Off the Stability Line, Lysekil, Sweden. See CONF-660817.

For not too heavy or too light nuclei, heavy-ion reactions are dominated by compound nucleus formation and neutron evaporation. It is, therefore, often possible to identify short-lived neutron-deficient reaction products without chemical or mass spectrometric separation, judging from excitation functions, cross-bombardments, and position of X-rays. As examples for the application of these methods, the identification of a 0.56 sec isomeric state in ^{128}La and of a 4.7 min isomer of ^{189}Au is described. Both activities were produced with ^{12}C and ^{14}N ions at the 150 cm heavy-ion cyclotron of the JINR Dubna. (auth)

30008 L_{II}-ELECTRON-GAMMA CORRELATION IN ^{199}Hg. Thun, J. E.; Toernkvist, S.; Stroem, S.; Falk, F. (Univ. of Uppsala). Z. Phys., 211: 352-9(1968).

The ($50L_{II}$-158 γ) directional correlation was measured in ^{199}Hg. The result is $A_{22} = +0.038 \pm 0.024$, which gives the mixing ratio for the 50-keV transition as $\delta = +0.017 \pm 0.006$. The accuracy of the method is discussed. (auth)

30009 LEVEL STRUCTURE OF ^{116}Sn AND ^{117}Sn FROM (p,d), (p,t), AND (p,p') REACTIONS. Yagi, K.; Saji, Y.; Ishimatsu, T.; Ishizaki, Y.; Matoba, M.; Nakajima, Y.; Huang, C. Y. (Tokyo Univ.). Nucl. Phys., A111: 129-46(1968).

The level structure of ^{116}Sn was investigated by the reactions ^{117}Sn(p, d), ^{118}Sn(p, t), and ^{116}Sn(p,p') with 55 MeV incident protons and that of ^{117}Sn by ^{118}Sn(p, d) and ^{117}Sn(p, p') reactions. The emitted particles were analyzed with a broad-range magnetic spectrometer. Angular distributions of emitted particles in the (p, d), (p, t), and (p, p') reactions are analyzed in terms of the DWBA method. A strong similarity between the ^{117}Sn(p, d) and ^{118}Sn(p, t) reactions is found in the excitation of all of the observed states in ^{116}Sn. Three new 2^+ states in ^{116}Sn were identified both from the (p, d) and (p, t) reactions and two excited 0^+ states were established. Spectroscopic factors for 25 states extracted from the $^{117, 118}$Sn (p, d) reactions are compared with theoretical predictions based on the pairing interaction plus quadrupole-quadrupole and octupole-octupole interactions. The agreement is reasonably good except for the 2^+ states at $E_x \approx 4$ MeV in ^{116}Sn. (auth)

30010 LEVELS IN ODD-MASS Sb AND I ISOTOPES STUDIED WITH THE (^{3}He,d) REACTION. Auble, R. L.; Ball, J. B.; Fulmer, C. B. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. Phys. Rev., 169: 955-62(May 20, 1968). (ORNL-P-3516).

The (^{3}He,d) reaction was used to study levels in the residual nuclei ^{125}Sb, ^{127}I, ^{129}I, and ^{131}I up to ≈4 MeV in excitation. The experiments were performed at a bombarding energy of 25 MeV using a broad-range magnetic spectrograph. Angular distributions for the deuterons were compared with distorted-wave Born-approximation predictions to obtain orbital angular-momentum transfers and spectroscopic factors for most of the observed levels. States reached by l equal to 0, 2, 4, and probably 5 were observed in each nucleus. A comparison of the present results with previous decay-scheme studies is also shown. (auth)

30011 LEVELS OF THE ^{150}Sm NUCLEUS EXCITED IN THERMAL NEUTRON CAPTURE. Lure, E. Ya.; Peker, L. K.; Prokof'ev, P. T. (Inst. of Physics, Riga). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser., No. 6, 3-12(1967). (In Russian).

The spectrum of internal conversion electrons emitted by ^{150}Sm after thermal neutron capture was studied. Two hundred and fifty conversion lines in the energy region 35 to 940 keV are found. A scheme of the excited states of the ^{150}Sm, which includes 4 "quasi-rotational" bands with $K^\pi = 0^+$ and bands with $K^\pi = 2^+$ and $K^\pi = 0$, based on the results obtained in the measurements, data of previously published studies, and comparison of interband reduced transition probabilities between states in the ^{152}Sm and ^{152}Gd nuclei, is proposed. (auth)

30012 MULTILEVEL ANALYSIS OF ^{239}Pu FISSION CROSS SECTION NEAR 83 eV. James, G. D. (Atomic Energy Research Establishment, Harwell, Eng.). J. Nucl. Energy, 22: 263-4(Apr. 1968).

The method of analysis used enabled the resonance energy, the reduced neutron width, and the fission width in each fission channel to be determined for up to ten resonances. A good multilevel fit was obtained only by introducing a second fission channel for spin-zero resonances. (UK)

30013 NEPTUNIUM (n,f) AND SULFUR (n,p) CROSS SECTIONS. Rago, P. F.; Goldstein, N. (Naval Radiological Defense Lab., San Francisco). Health Phys., 14: 595-7(June 1968).

The fission foil-detector method for measuring neutron fluence was used to determine the fission cross section of ^{237}Np. Measurements were made for neutron energies between 12.5 and 17.5 MeV, an energy interval for which only limited data are available. The method lends itself favorably to fission cross section determination because fission track counts at each energy can be compared directly with those for a fissionable material with a well-defined cross section. The reference fissionable material selected was ^{238}U. Sulfur pellets were also exposed to neutrons with energies between 12.5 and 17.5 MeV. Pellets were calibrated to measure fluence by exposure to 14.1 MeV neutrons, where the (n,p) cross section is 248 mbarn. Based on the calibration at 14.1 MeV and on the ^{238}U(n,f) reaction, ^{32}S(n,p) cross sections were determined.

In addition, the ^{238}U foil-detector was applied to the measurement of neutron fluence between 2.17 and 2.88 MeV at a low-voltage neutron generator in order to check the $^{32}S(n,p)$ cross section in that energy region. (auth) (UK)

30014 NEUTRON CAPTURE CROSS SECTIONS AND RESONANCE PARAMETERS OF RHENIUM FROM 0.01 eV TO 30 keV. Friesenhahn, S. J.; Gibbs, D. A.; Haddad, E.; Froehner, F. H.; Lopez, W. M. (General Atomic, Inc., San Diego). J. Nucl. Energy, 22: 191-210(Apr. 1968). (GA-8189).

Measurements on ^{185}Re and ^{187}Re employing a large liquid scintillator and a pulsed neutron source are described. High-resolution neutron total and capture cross sections are presented from 0.01 and 10 eV. Resonance parameters obtained with shape and area techniques from capture, transmission, and self-indication data are listed from 0 to 100 eV. Average parameters obtained from measured average cross sections are compared with values obtained from resonance parameters. (auth) (UK)

30015 NEUTRON STRENGTH FUNCTIONS AND AVERAGE TOTAL CROSS SECTIONS. I. A NEW METHOD. Tabony, Robert H. (Duke Univ., Durham, N. C.); Seth, Kamal K. Ann. Phys. (N.Y.), 46: 401-34(Feb. 1968).

Neutron total cross sections of In, Sb, Re, and Hg were measured in the energy region from 30 to 650 keV using a number of different sample thicknesses. A technique is developed for the analysis of the multiple-thickness transmission data to uniquely determine s-, p-, and d-wave strength functions and potential scattering phase shifts. The method exploits the differences in the behavior of the areas under transmission dips of s- and p-wave resonances as a function of sample thickness, and is shown to be well-suited for the keV region of neutron energies. (auth)

30016 NUCLEAR ORIENTATION OF ^{125}Sb. Andrews, H. R.; Knott, T. F.; Greenebaum, B.; Pipkin, F. M. (Harvard Univ., Cambridge, Mass.). Phys. Rev., 169: 978-82(May 20, 1968).

The anisotropies of the 176-, 379-, 426-, 598- plus 604-, 633-, and 668-keV γ rays from oriented ^{125}Sb were observed. The results corroborate the spin assignment of $^5/_2$ to the 668-keV level, $^7/_2$ to the 633-keV level, and $^9/_2$ to the 321-keV level. The following mixing parameters $\delta(E2/M1)$ were found: 633-keV γ ray, $\delta = +0.327 \pm 0.004$ or $+32.4$; 426-keV γ ray, $\delta = -0.512 \pm 0.025$ or -1.05 ± 0.05; 176-keV γ ray, $-1.49 \leq \delta \leq -0.570$. The data suggest that the β feeds to the 640-, 633-, and 321-keV levels are mostly L = 1. The average magnetic hyperfine energy of ^{125}Sb in iron was found to be $(572 \pm 3)_{\mu N}$ kG by simultaneously orienting ^{60}Co and ^{125}Sb. (auth)

30017 OBSERVATION OF A GAMMA TRANSITION INDUCED IN A TARGET NUCLEUS BY STOPPING PIONS. Carrigan, R. A. Jr. (Carnegie-Mellon Univ., Pittsburgh); Gupta, P. D.; Sutton, R. B.; Suzuki, M. N.; Thompson, A. C.; Gote, R. E.; Prestwich, W. V.; Gaigalas, A. K.; Raboy, S. Phys. Rev., 169: 963-5 (May 20, 1968).

Evidence is given for the excitation of the 482-keV state in a tantalum target by stopping pions. The yield relative to a pionic x-ray transition is found to depend on target thickness. Several mechanisms for the excitation of the state are discussed. It appears that at least part of the excitation may be due to production of neutrons in the pion absorption process followed by inelastic scattering of the neutrons elsewhere in the target. (auth)

30018 PHENOMENOLOGICAL DESCRIPTION OF ENERGY LEVELS OF MEDIUM-HEAVY NUCLEI. Sood, P. C. (Univ. of Alberta, Edmonton). Progr. Theor. Phys. (Kyoto), 39: 535-6 (Feb. 1968).

It is shown that Ejiri's relation $E(I) = kI(I + 1) + aI$ does not reproduce the excitation energies quantitatively for the deformed or nearly deformed nuclei but gives the general trends and systematics for nuclei over the rotational and vibrational regions. It is also shown that a better quantitative description of known energy levels is obtained using a semi-empirical formula (Phys. Rev., 161: 1063(1967)) which involves effectively summing up an infinite power series in $I(I + 1)$ by assuming a relation between the coefficients of the successive higher-order correction terms. (D.C.W.)

30019 PLANS FOR STUDYING THE SHORT-LIVED RADIATIONS FROM FISSION PRODUCTS USING A MASS SPECTROMETER. Ewald, H. (Univ., Giessen, Ger.). Ark. Fys., 36: 311-18(1967).

From International Symposium on Why and How Should We Investigate Nuclides Far Off the Stability Line, Lysekil, Sweden. See CONF-660817.

In a special, large mass spectrometer fission products can be separated within 10^{-6} seconds after the fission processes. Therefore such an apparatus is suitable for the study of the short-lived radiations of these products. A short description of the fission particle mass spectrometer at the reactor Garching and of the work done with it is given. This apparatus is delivering about one separated particle per mass line per second. Plans are discussed to come to more than 1000 or 10,000 particles per line per second by combining a focusing parabola spectrograph with a high flux reactor. By an additional magnetic field particles of a selected mass which are distributed along a part of a parabola of about 50 cm length can be energy-focused onto small detectors of 1 to 2 cm size. (auth)

30020 PRODUCTION OF ^{149}Tb IN GOLD BY HIGH-ENERGY PROTONS AND ITS USE AS AN INTENSITY MONITOR. Steinberg, E. P.; Stehney, A. F.; Stearns, Carole; Spaletto, Irene (Argonne National Lab., Ill.). Nucl. Phys., A113: 265-71(1968).

Monitoring high-energy proton beams by alpha counting of intact gold foils is shown to be comparable in accuracy with chemical isolation techniques. The half-life of ^{149}Tb was determined to be 249 ± 2 min. Cross sections for the production of alpha-emitting rare-earth nuclides from gold were determined by chemical separation and spectral analysis. A value of 1.05 ± 0.05 mb for $\sigma_{Au}(^{149}Tb)$ (α-branch) was obtained by comparison with $\sigma_{Al}(^{24}Na)$ at 11.5 GeV. The effective range of ^{149}Tb α-particles in gold was 10.6 ± 0.5 mg/cm^2 under the counting conditions used. (auth)

30021 PROPERTIES OF NUCLEI IN THE SUPER-HEAVY REGION. Truran, J. W.; Cameron, A. G. W. (Goddard Space Flight Center, New York. Yeshiva Univ., New York). Ark. Fys., 36: 509-20(1967).

From International Symposium on Why and How Should We Investigate Nuclides Far Off the Stability Line, Lysekil, Sweden. See CONF-660817.

The nuclear properties of super-heavy nuclei were investigated employing a revised atomic mass formula. Improved expressions for both the nuclear level densities and the nuclear radiation widths permit more accurate calculations of the neutron capture cross sections for these nuclei. The results of these calculations are in good agreement with the cross sections for the heavy uranium isotopes inferred from the yield curves of recent underground thermonuclear explosions. These calculations are relevant both to interpretations of the yield curves for the abundances of heavy nuclei produced in underground thermonuclear explosions and to discussions of the role of fast neutron capture in the synthesis of the heavy elements. (auth)

30022 SOME ASPECTS OF THE STUDY OF FISSION. Thompson, Stanley G. (Univ. of California, Berkeley). Ark. Fys., 36: 267-77(1967).

From International Symposium on Why and How Should We Investigate Nuclides Far Off the Stability Line, Lysekil, Sweden. See CONF-660817.

A brief review is given of research work being performed at Berkeley on the fission process. Some of the topics covered are emission of prompt gamma rays, conversion electrons, and x-rays; heavy ion bombardments; light-weight nuclei emitted in the spontaneous fission of ^{252}Cf; angular distributions of fission fragments from the $^{206}Pb + {}^4He \rightarrow$ fission reaction; and fission barriers of some elements below radium. (S.F.L.)

30023 SOME REMARKS ON THE NEW REGION OF DEFORMATION. Morinaga, H. (Max Planck Institut fuer Kernphysik, Heidelberg. Tokyo Univ). Ark. Fys., 36: 609-11(1967).

From International Symposium on Why and How Should We Investigate Nuclides Far Off the Stability Line, Lysekil, Sweden. See CONF-660817.

Energy levels observed in even Xe isotopes formed by bombarding Te with ^4He ions are reported. A technique used in search for the existence of the trineutron is briefly described. (S.F.L.)

30024 SPECTRUM OF INTERNAL CONVERSION ELECTRONS ASSOCIATED WITH THE TRANSMUTATION OF ^{228}Th INTO ^{224}Ra. Costa, Maria Otilde; Grade, Maria Regina Sales (Faculdade de Ciencias, Lisbon). Port. Phys., 4: 267-80(1966). (In Portuguese).

A nuclear emulsion study was made of the conversion electrons emitted on the disintegration of ^{228}Th. The L and M internal conversion coefficients of the 84.5-keV γ radiation were determined; the experimental results are: $\alpha_L = 14 \pm 3$; $\alpha_{L_{II}} = 7.6$; $\alpha_{L_{III}} = 6.3$; $\alpha_{M+N+\ldots} = 3.8 \pm 0.9$; and $\alpha_t = 18 \pm 4$. (auth)

30025 STUDY OF DELAYED PROTON EMITTERS HEAVIER THAN TIN. Karnaukhov, V. A.; Ter-Akopyan, G. M. (Joint Inst. for Nuclear Research, Dubna, USSR). Ark. Fys., 36: 419-29(1967).

From International Symposium on Why and How Should We Investigate Nuclides Far Off the Stability Line, Lysekil, Sweden. See CONF-660817.

The bombardment of metallic targets with heavy-ion beams was used to obtain highly neutron-deficient nuclei for studies of delayed proton emission. Targets of ^{92}Mo and ^{94}Mo were bombarded with ^{20}Ne and ^{22}Ne in the internal beam of a 310-cm cyclotron. The radioactive products were knocked from the target, slowed down in the Al catcher, and periodically brought to the charged particle spectrometer. A target of ^{102}Pd was bombarded with ^{12}C ions in the external beam of a 150-cm cyclotron. The radioactive products in this case were gathered by a gas jet technique. Decay curves of proton activity following bombardment are given for each case. The excitation function for production of ^{111}Te in the ^{102}Pd + ^{12}C reaction is given at 40 to 75 MeV. The proton spectrum and decay scheme for ^{111}Te are also presented. Yield curves of proton activities produced in the ^{92}Mo + ^{20}Ne, ^{92}Mo + ^{22}Ne, and ^{94}Mo + ^{20}Ne reactions are also presented and discussed. The calculated values for the cross sections of the reactions ^{92}Mo(^{20}Ne,4-6n) are given in graphical form. (S.F.L.)

30026 EXPERIMENTAL RESULTS ON THE STUDY OF ULTRA-NEUTRON DEFICIENT NUCLEI. Macfarlane, Ronald D. (McMaster Univ., Hamilton, Ont.). Ark. Fys., 36: 431-43(1967).

From International Symposium on Why and How Should We Investigate Nuclides Far Off the Stability Line, Lysekil, Sweden. See CONF-660817.

Research work in the production and study of ultra-neutron-deficient nuclei is reviewed. Excitation functions for the production of various nuclides in the reaction ^{144}Sm + ^{20}Ne and the alpha spectrum of some of the products of this reaction at 171 MeV bombarding energy are given. Alpha decay properties of nuclei in the Te region are discussed. A recoil collection and detection system is described. The half-lives of most ultra-neutron-deficient nuclides of interest are so short that chemical identification of the new nuclear species is extremely difficult. The problems of identifying these nuclei are briefly discussed. (S.F.L.)

30027 HEAVY-ION PROJECTILES AND IN-BEAM SPECTROSCOPY. Diamond, R. M.; Stephens, F. S. (Univ. of California, Berkeley). Contract W-7405-eng-48. Ark. Fys., 36: 221-36(1967). (UCRL-17143; CONF-660817-10).

From International Symposium on Why and How Should We Investigate Nuclides Far Off the Stability Line, Lysekil, Sweden. See CONF-660817.

In-beam spectroscopy, though sometimes involving technical problems not faced by more conventional nuclear spectroscopy, allows the study of a wide range of nuclei, including, in principle, all the beta-stable and (bound) neutron-deficient species. A special advantage of this wide range of species is that a series of related nuclei can be populated in a uniform way, enabling one to study the systematics of the levels of interest. For such in-beam studies (and for some out-of-beam purposes, also) the use of heavy ions as bombarding projectiles offers certain advantages. Four such advantages, high nuclear charge, large linear momentum transfer, high nuclear product specificity, and large angular momentum transfer are discussed briefly. (S.F.L.)

30028 THE DECAY PROPERTIES OF ^{127m}Xe. Geiger, J. S.; Graham, R. L.; Gelletly, W. (Chalk River Nuclear Labs., Ont.). Ark. Fys., 36: 197-203(1967).

From International Symposium on Why and How Should We Investigate Nuclides Far Off the Stability Line, Lysekil, Sweden. See CONF-660817.

^{127m}Xe was produced by bombarding PbI_2, and condensed I targets with protons. With the beam interrupted the decay of the internal conversion electron lines and the gamma-ray peaks of the known 125 and 175 keV gamma transitions were followed for >6 half-lives using Si(Li)- and Ge(Li)-detectors. The half-life of this isomer is 69.2 ± 1.0 sec. The measured K/ΣL ratio for the 175 keV gamma transition of 1.6 ± 0.1 confirms its assignment as an E3 isomeric transition. K/ΣL for γ 125 keV is 7.1 ± 0.8 and indicates dominantly, dipole character for this transition. The measured 180°/90° anisotropy of the gamma 175–gamma 125 angular correlation gives $A_2 = -0.069 \pm 0.011$ after geometrical correction and assuming $A_4 = 0$. On assumed sequences of $^{11}/_2-$ (E3) $^5/_2+$ (M1, E2) $^3/_2+$ and $^9/_2-$ (E3) $^3/_2+$ (M1, E2) $^1/_2+$ the E2 admixtures in gamma 125 indicated by this result are (0.75 ± 0.25)% and (1.5 ± 0.5)% respectively. The mean life of the 125 keV level was measured by the delayed coincidence method and is τ = 0.41 ± 0.02 ns. The M1 transition rate is 0.028 Weisskopf units and that of the ~1% E2 components is ~12 Weisskopf units. No evidence was found for a third transition in the ^{127m}Xe decay. (auth)

30029 THE RADIOACTIVE DECAY OF ^{144}Eu. Geiger, J. S.; Graham, R. L. (Chalk River Nuclear Labs., Ont.). Ark. Fys., 36: 191-6(1967).

From International Symposium on Why and How Should We Investigate Nuclides Far Off the Stability Line, Lysekil, Sweden. See CONF-660817.

The (p,p′) and (d,d′) studies of Christensen and Yang [Nucl. Phys. 72: 657(1965)] indicate two new 0^+ excited levels in ^{144}Sm. The possibility that these states are also fed by the radioactive decay of ^{144}Eu produced by ^{144}Sm(p,n) was investigated. The intensities of the internal conversion lines depopulating these states were studied during and following the irradiation of a metallic ^{144}Sm target (94% ^{144}Sm) with 12 MeV protons. The conversion lines were selected with a seven gap orange beta spectrometer. The K conversion lines of the 1659 ± 3 keV and 2481 ± 4 keV transitions were observed to decay with a half-life of 10 ± 1 sec. The gamma-ray spectrum associated with this activity was studied with a Ge(Li)-detector. Gamma rays of 511, 820, and 1661 keV were found to decay with the 10 sec half-life. The results are consistent with the decay of ^{144}Eu to levels in ^{144}Sm at 0 keV (0+), 1659 keV (2+), and 2481 keV (0+). Measurements of the p′–K 1659 time correlation yields an upper limit for the mean life of the 1659 keV state of τ ≤ 0.7 ns. A similar study of the p′–K 2481 keV time correlation showed no true coincidences and any (p,p′) feed to the 2481 keV level depopulated by these conversion electrons must be very weak. (auth)

30030 EXPERIMENTS WITH VERY SHORT-LIVED FISSION PRODUCTS. I. LOOP EXPERIMENTS WITH AN EMANATION SOURCE. Amiel, S.; Gilat, J.; Notea, A.; Yellin, E. (Soreq Nuclear Research Center, Yavne, Israel). Ark. Fys., 36: 169-76 (1967).

From International Symposium on Why and How Should We Investigate Nuclides Far Off the Stability Line, Lysekil, Sweden. See CONF-660817.

Very short-lived activities of Kr, Xe and their decay products were obtained from a fission source placed in an external thermal neutron beam of a reactor. The rare gases were extracted from an emanating source of uranyl stearate sandwiched between two porous membranes and swept by a stream of nitrogen through a series of filters and traps to a counting station 4 meters away. Kr and Xe were separated from each other by selective freezing. The decontamination factor from non rare-gas activities, especially halogens, was ≥100. A remotely operated shutter was employed for studying the transport time as a function of the sweeping gas pressure, and for following the growth and decay of the activities collected. With the shutter left open, steady sources of short-lived isotopes were obtained. Prominent gamma rays of 32 sec ^{90}Kr (120, 240, 540, and 1125 keV), 8.5 sec ^{91}Kr (109 keV, ~0.65 photons/disintegration and 509 keV, ~0.25 photons/disintegration) and 1 to 2 sec $^{92-93}$Kr (141 keV, ≥0.5 photons/disintegration) as well as other, less abundant gamma rays were observed. (auth)

30031 NUCLEAR SPECTROSCOPY OF LIGHT PLATINUM AND MERCURY ISOTOPES. Naumann, R. A.; Petry, R. F.; Evans, J. S. (Princeton Univ., N. J.). Ark. Fys., 36: 177-82 (1967).

From International Symposium on Why and How Should We Investigate Nuclides Far Off the Stability Line, Lysekil, Sweden. See CONF-660817.

The spallation of Pb with 3-GeV protons is briefly discussed as a technique for producing neutron-deficient isotopes of Hg and Pt for spectroscopic studies. Partial level schemes are given for ^{192}Hg, ^{194}Hg, ^{196}Hg, ^{198}Hg, and ^{188}Pt which were obtained using these techniques. (S.F.L.)

30032 ALPHA EMISSION FROM LIGHT POLONIUM ISOTOPES. Le Beyec, Y.; Lefort, M. (Univ., Paris, Orsay, France). Ark. Fys., 36: 183-90(1967).

From International Symposium on Why and How Should We Investigate Nuclides Far Off the Stability Line, Lysekil, Sweden. See CONF-660817.

Polonium nuclides of mass numbers 197 to 203 disintegrate by electron capture and alpha emission. In a study of excitation functions of (p,xn) reactions induced on Bi targets by 60 to 150 MeV protons, each Po isotope was identified by the determination of the threshold energy for their production and by counting both the alpha particles emitted and the gamma radiation of the Pb and Tl daughters. New isomeric states were found for mass numbers 203, 201, 199, and 197. (auth)

30033 ON-LINE MASS-SPECTROMETRIC METHOD FOR THE STUDY OF SHORT-LIVED Rb, Cs, AND Na ISOTOPES. Amarel, I.; Bernas, R.; Chaumont, J.; Foucher, R.; Jastrzebski, J.; Johnson, A.; Klapisch, R.; Teillac, J. (Centre National de la Recherche Scientifique, Orsay, France). Ark. Fys., 36: 77-89 (1967).

From International Symposium on Why and How Should We Investigate Nuclides Far Off the Stability Line, Lysekil, Sweden. See CONF-660817.

Results are reported on measurements made with the ORSAY on-line mass spectrometer set-up. The fission yields of Cs isotopes from mass 128 to 144 and Rb from mass 83 to 98 bring new data on production cross sections of short-lived nuclides in the fission of ^{238}U by 150 MeV protons and provide identification of the new isotopes ^{96}Rb, ^{97}Rb, and ^{98}Rb. The spallation of silicon leading to ^{29}Na to ^{25}Na at the same energy has also been studied. Counting rates obtained clearly indicate the feasibility of this method for nuclear spectroscopy of nuclides far from stability; experiments are at present under way in this direction and preliminary results are presented. (auth)

30034 ISOTOPE SEPARATOR ON-LINE STUDIES OF GASEOUS FISSION PRODUCTS. Holm, G.; Borg, S.; Faegerquist, U.; Kropff, F. (Research Inst. for Physics, Stockholm. Research Inst. of National Defence, Stockholm). Ark. Fys., 36: 91-7(1967).

From International Symposium on Why and How Should We Investigate Nuclides Far Off the Stability Line, Lysekil, Sweden. See CONF-660817.

On-line techniques were used at the Stockholm electromagnetic isotope separator to study decay properties of inert gas fission products. Results were obtained on single closed shell and neighboring nuclei. (auth)

30035 SYNTHESIS AND STUDY OF THE PROPERTIES OF ELEMENT 102. Flerov, G. N. At. Energ. (USSR), 24: 5-17 (Jan. 1968). (In Russian).

A review is given of the work on the synthesis of element 102. It was asserted that works before 1957 to 1961 contain inaccurate information on the properties of isotopic element 102 and that some of the data are completely false. The most complete and reliable data on the five isotopes of element 102 were obtained at Dubna in 1963 to 1966. In these studies, the α decay and the spontaneous fission as well as the chemical behavior of the atoms of this new element were investigated. The results obtained on the nuclear properties were completely confirmed in later studies made at Berkeley. (tr-auth)

30036 THE DECAY $^{109}Cd \rightarrow {}^{109}Ag$. Foin, C.; Gizon, A.; Oms, J. (Institut des Sciences Nucleaires, Grenoble, France. CEN, Grenoble, France). Nucl. Phys., A113: 241-8(1968). (In French).

The 88-keV transition in ^{109}Ag was studied by means of a double-focusing magnetic β-spectrometer and a solid-state Ge(Li) detector. By comparison with the 84-keV transition in ^{170}Yb, the energy was found to be 88.09 ± 0.03 keV and the internal conversion coefficient $\alpha_K = 12.7 \pm 0.9$. The internal conversion spectrum was recorded. All internal conversion measurements agree very well with a pure E3 assignment and theory. The fluorescence yield deduced from the Auger spectrum is $\omega_K = 0.834 \pm 0.018$. (auth)

30037 THE ENERGY OF ^{109}Cd GAMMA RADIATION. Furuta, T.; Rhodes, J. R. (Texas Nuclear Corp., Austin). Int. J. Appl. Radiat. Isotop., 19: 483-5(May 1968).

An attempt was made to determine the ^{109}Cd gamma-ray energy more precisely, using a high-resolution solid-state detection system (Ge(Li)). Results are summarized in tabular form. The energy of the ^{109}Cd gamma ray was found to be 88.21 keV. (UK)

30038 TRANSITION RATES OF FAST, ALLOWED BETA TRANSITIONS BETWEEN DEFORMED NUCLEI IN THE RARE-EARTH REGION. Zylicz, Jan; Hansen, P. G.; Nielsen, H. L.; Wilsky, K. (Inst. of Nuclear Research, Swierk, Poland. Univ. of Aarhus, Denmark). Ark. Fys., 36: 643-50(1967).

From International Symposium on Why and How Should We Investigate Nuclides Far Off the Stability Line, Lysekil, Sweden. See CONF-660817.

The available evidence on allowed, unhindered beta transitions in deformed nuclei is reviewed on the basis of 38 cases in both odd-mass and even-mass nuclei. The experimental transition rates are found to be typically 20 times lower than the pure Nilsson model predictions, and typically 8 times lower than predicted by the Nilsson model plus pairing corrections. A systematic retardation of the fastest Gamow–Teller transitions by roughly an order of magnitude is also observed outside of the deformed regions. (auth)

30039 USE OF THE (p,n) REACTION TO MEASURE PROTON ATOMIC STOPPING POWERS IN Ag, Cd, In, AND Sn. Johnson, C. H.; Kernell, R. L. (Oak Ridge National Lab., Tenn.). Phys. Rev., 169: 974-7(May 20, 1968). (ORNL-P-3641).

The (p,n) reaction was used to measure the proton atomic stopping power for 3.75- to 5.5-MeV protons on Ag, Cd, In, and Sn. One feature of the method is that the foils were mounted on solid backings. The results are expressed by means of the Bethe relativistic stopping-power formula in terms of a single parameter corresponding to 39.35 ± 0.2 keV cm²/mg for 4.5-MeV protons on Ag. This result is in excellent agreement with other recent work with different techniques. (auth)

30040 A LINEAR-MOTION BENT CRYSTAL SPECTROMETER AND THE DECAY OF ^{172}Tm. Otteson, Otto Harvey. Salt Lake City, Utah State Univ., 1967. 102p.

Thesis.

This investigation consists of two parts: the development of a new design of a bent-crystal gamma-ray spectrometer and a study of the decay of ^{172}Tm. The bent-crystal spectrometer designed and constructed utilizes the DuMond transmission geometry with fixed detector. It has, however, four major distinguishing features: as a means of changing the Bragg angle the diffraction crystal moves only in translation (i.e., without rotation); the geometry employed requires a small linear motion of the source to maintain it on the focal circle; an aperture system consisting of a shield and stops is used to prevent the direct beam radiation from reaching the detector; and the radius of the focal circle is not a fixed property of the spectrometer. Using a (310) quartz crystal bent to a two meter radius of curvature the x-ray and gamma-ray energies in the decay of $^{182,183}Ta$ were measured with results which are in good agreement with other precision measurements of these transitions. The second portion of this investigation is a study of the levels in $_{70}Yb^{172}$ from the decay of $_{69}Tm^{172}$. This study utilizes the new Ge(Li) detectors to obtain high-resolution singles and coincidence spectra. A multiparameter analyzer was used for coincidence measurements. Gamma-ray energies and intensities were determined. The measurements made in this study indicate the presence of 49 gamma rays. The level scheme proposed for $_{70}Yb^{172}$ has states with energies, spins and parities of 0.0(0^+), 78.70(2^+), 260.2(4^+), 1043(0^+), 1119(2^+), 1172.3(3^+), 1262.9(4^+), 1375.8(5^+), 1466.0(2^+), 1476.8(1^-), 1549.2(3^+), 1750.0(4^+), and 1806(4^+) keV. The first two excited states are members of a K = 0 ground-state rotational band. The levels at 1043 and 1119 keV are interpreted as members of a rotational band with K = 0. The data concerning the levels at 1172.3, 1262.9, and 1375.8 keV are consistent with the previous interpretation that they are members of a K = 3 rotational band. A K-2 band with levels at 1466.0 and 1549.2 keV is interpreted as a γ-vibrational band. It is suggested that the 1476.8-keV level is an octupole vibrational state. The level at 1608.6 keV is interpreted as a K = 2 two neutron state with possible rotational levels at 1700.6 and 1806 keV. (Disser. Abstr.)

30041 DECAY SCHEME STUDIES OF SOME NEUTRON-DEFICIENT OSMIUM AND RHENIUM ISOTOPES. Hofstetter, Kenneth John. Lafayette, Ind., Purdue Univ., 1967. 151p.

Thesis.

Scintillation and semiconductor detectors have been used in singles and coincidence measurements to investigate the decay properties of neutron-deficient osmium and rhenium isotopes which were produced in proton and helium ion bombardments of tantalum and tungsten targets. ^{179}Re decays by electron capture with a half-life of 19.7 ± 0.5 min; the energies and relative intensities of many γ-rays emitted in ^{179}Re decay are reported. The positron decay branch previously assigned to 20-hr ^{180}Re was shown to occur in the decay of 13-hr ^{182}Re, and no evidence for a ^{180}Re isomer having a half-life longer than a few minutes was found. The existence of 2.45-min ^{180}Re was confirmed; it decays predominantly by electron capture with the emission of intense 902.2- and 103.6-keV γ rays. By establishing its genetic relation with 2.45-min ^{180}Re, a new isotope ^{180}Os, decaying by electron capture with a 21.7 ± 0.6 min half-life was identified. The half-life for the electron-capture decay of ^{181}Os was determined to be 105 ± 3 min in disagreement with previous values reported for this isotope; a new ^{181}Os isomer decaying with a half-life of 2.9 ± 0.1 min was also discovered and characterized. Reasons are advanced for believing that the ^{179}Re, ^{180}Os and 105 min ^{181}Os activities identified here were observed previously by other workers but were incorrectly assigned to ^{180}Re, ^{181}Os, and ^{183m}Os, respectively. On the basis of more detailed investigations of the radiations emitted in ^{180}Re and ^{180}Os decay, a decay chain is proposed for A = 180. Its most interesting feature is a 2^- two-quasi-particle state occurring at 1006 keV in ^{180}W which de-excites almost exclusively to the first excited state by a predominantly E1 transition. Intensive studies of the radiations emitted in the decay of the ^{181}Os isomers were also performed. It is proposed that 2.9-min ^{181}Os decays by an allowed unhindered beta transition $n\ 7/2^-[514] \rightarrow p\ 9/2^-[514]$ followed by a two-gamma cascade to the ^{181}Re ground state; some difficulties encountered in interpreting the 105-min ^{181}Os decay data have not yet been resolved. All the results are discussed in terms of current nuclear models. (Disser. Abstr.)

30042 NUCLEAR g-FACTORS OF THE 2^+ ROTATIONAL STATES IN ^{150}Nd, ^{162}Dy, ^{164}Dy, ^{166}Er, ^{168}Er, AND ^{170}Er. Kurfess, James Daniel. Cleveland, Case Inst. of Tech., 1967. 147p.

Thesis.

The nuclear g-factors and mean lives of the 2^+ rotational states of ^{150}Nd, ^{162}Dy, ^{164}Dy, ^{166}Er, ^{168}Er, and ^{170}Er were measured by the pulsed beam technique. The time differential precession of the angular distribution of the de-excitation gamma radiation was measured following coulomb excitation by a pulsed proton beam. Metallic neodymium targets and dysprosium-copper and erbium-copper liquid eutectic targets were used at about 900°C. Paramagnetic correction factors for free tripositive ions were used in the g-factor calculations. Strong perturbations causing an exponential attenuation of the anisotropy of the angular distribution were observed in the liquid targets. These perturbations are interpreted to be magnetic in character, and the exponential decay constants, λ_2, are calculated. In addition new measurements of the g-factor and mean life of the 2^+ state in ^{186}W yield the results $g = .351 \pm .030$, $\tau = 1.61 \pm .03$ ns. Comparisons are made with other experiments and with theoretical predictions. (Disser. Abstr.)

30043 DETERMINATION OF THE PROPERTIES OF NUCLEAR ENERGY LEVELS BY THE RESONANCE FLUORESCENCE OF NEUTRON CAPTURE GAMMA RAYS. Ramchandran, Shankarnarayan. College Station, Tex., Texas A and M Univ., 1967. 139p.

Thesis.

Several cases of nuclear resonance scattering below the neutron emission threshold energy region have been observed using discrete gamma rays produced by the radiative capture of neutrons in elements. Eight such cases were studied (8.496 MeV in Zr; 7.64 MeV in ^{203}Tl; 7.416 MeV in ^{209}Bi; 7.277 MeV in ^{208}Pb; 7.149 MeV in ^{209}Bi; 7.01 MeV in Sn; 6.474 MeV in Cd; 4.903 MeV in Hg); and the angular momentum of the excited states was determined by measuring the angular distribution of resonantly scattered gamma rays. In all these cases the observed transition was a dipole type. In the first five of the above cases, where the resonance scattering competes favorably with non-resonance scattering, a resonance self-absorption and a scattering experiment were performed to obtain information on the level widths. The observed range of ground-state transition widths varies from a few tenths of an eV to a few eV. From a comparison of the values of radiative transition widths of the virtual states obtained from neutron resonances, the measured values of the level widths for the γ-ray transitions below the neutron emission threshold reported in this investigation are larger by approximately a factor of 10 in most of the cases. (Disser. Abstr.)

30044 SOME PARAMETERS OF THE EXCITED STATES OF THE NUCLEI ^{103}Rh, ^{57}Fe, AND ^{169}Tm. George, M. Cherian. University, Ala., Univ. of Alabama, 1967. 108p.

Thesis.

Some of the parameters of the excited states of the nuclei ^{103}Rh, ^{57}Fe and ^{169}Tm were studied by experimental methods. In the case of ^{103}Rh and ^{57}Fe, the measurement and the analysis of the anisotropy coefficients of gamma–gamma angular correlations of cascade transitions were used to study the spins and parities of the levels. The decay of ^{169}Yb to ^{169}Tm was investigated by the gamma–gamma coincidence technique as well as by the study of gamma-ray singles spectrum. The assignment of spin and parity for the two top levels, namely the 650-keV and 538-keV levels in ^{103}Rh, has been conflicting and inconclusive. The true anisotropy coefficients in the unperturbed angular correlation between the 555-53 keV and the 440-53 keV gamma-ray cascades were measured by using a dilute aqueous solution of enriched ^{103}Ru, the parent nucleus. Consistent values of the anisotropy coefficients obtained were $A_2 = -0.131 \pm 0.140$ and $A_4 = -0.046 \pm 0.50$ for the 555-53 keV gamma-ray cascade and $A_2 = +0.121 \pm 0.060$ and $A_4 = +0.08 \pm 0.10$ for the 440-53 keV gamma-ray cascade. These values of the A_k coefficients led to the assignments of spin and parity of $5/2^+$ for the 650-keV level and of $7/2^+$ for the 538-keV level. It is also concluded that the 53-keV gamma ray is a pure M1 transition, that the 440-keV gamma ray is almost a pure M1 transition, and that the 555-keV gamma ray is a pure E2 transition. ^{57}Co decays into ^{57}Fe by orbital electron capture. The directional correlation pattern between the 122- and the 14.4-keV gamma rays was studied providing different environments for the decaying iron nucleus by using $CoCl_2$ liquid and solid sources and also a $Co(NO_3)_2$ liquid source. The measured anisotropy coefficients in all these cases were overlapped by the range of experimental errors. Therefore, it was concluded that the attenuation of the correlation pattern due to extranuclear interactions was negligible. From the unperturbed angular correlation functions, the anisotropy coefficients were found to be $A_2 = -0.002 \pm .006$ and $A_4 = +0.004 \pm .004$. From these results and from the known spins and parities of the energy levels involved in these transitions, it was concluded that both the 122-keV and the 14.4-keV gamma rays are M1 + E2 transitions with with $\delta_1 = .19 \pm .02$ and $\delta_2 = .251 \pm .04$, respectively. The singles spectrum of the gamma rays emitted in the decay of ^{169}Yb by orbital electron capture was measured by using a Ge(Li) detector. Coincidence spectra were studied in the case of three gamma-ray cascades. Energy selection was made on the photopeaks of the 93.6-keV, 177.2-keV and the 261-keV gamma rays in three different experiments. Coincidences between the Tm x rays and all the gamma rays of ^{169}Yb were also measured. In addition to the previously reported gamma rays, 160-keV, 316.8-keV and 336-keV gamma rays were observed. These gamma rays were confirmed as transitions emitted from the decay of ^{169}Yb. For the first time two gamma rays of 625-keV and 515-keV energies were observed to be emitted following the orbital electron capture decay of ^{169}Yb. The 625-keV and the 515-keV gamma rays, the 160-keV gamma ray, and the 316.8-keV gamma rays were fitted into the existing level scheme as transitions emanating from the 633-keV level, thus confirming the excitation of the 633-keV level in ^{169}Tm by orbital electron capture process in ^{169}Yb. It was found that it was not possible to fit the 336-keV gamma ray in the existing decay scheme without introducing new energy levels. (Diss. Abstr.)

Nuclear Theory

Refer also to abstracts 29638, 29804, 29838, 29902, 29903, 29907, 29908, 29915, 29927, 29934, 29940–29942, 29977, 29985, 29991, 29996, 30018, and 30021.

30045 (CEA-Bib-107) DETECTION RADIATIVE DE LA RMN D'ETATS NUCLEAIRES EXCITES. (Radiative Detection of the Nuclear Magnetic Resonance of Excited Nuclear States). Nechtschein, Maxime (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Mar. 1968. 27p. (In French). Dep.

Methods are described for observing the magnetic resonance between sublevels of excited nuclear states. The nuclear magnetic resonance is detected by the change which it produces in the angular distribution of the radiation emitted by the radioactive nuclei. The case of a statistic nuclear orientation, obtained either by applying a strong magnetic field at very low temperature or as the result of a nuclear reaction, and the case of the perturbed angular correlation are considered. (auth)

30046 (LA-3774) SYMMETRIC FISSION OF A TWO-PARAMETER LIQUID DROP. Lawrence, James N. P. (Los Alamos Scientific Lab., N. Mex.). Aug. 1967. Contract W-7405-eng-36. 40p. Dep. CFSTI.

Thesis. Submitted to Vanderbilt Univ., Nashville.

A review of fission theory is presented with attention focused on the liquid drop model. The contour of the liquid drop is described by a two-parameter equation in order that dynamic calculations could be performed. To obtain an indication of the accuracy to be expected in the dynamics, calculations of the fission-barrier energy and other saddle-point properties were made and compared with other studies. The equations of motion were derived under the assumptions of incompressibility and irrotational fluid flow. With the time-dependent coordinates being the two shape parameters, a velocity potential is defined as a sum of terms, each of which satisfies Laplace's equation. The coefficients of each term are fixed by the boundary conditions and are seen to be functions of the shape parameters and their first derivatives. Lagrangian mechanics furnish the basis for the equations of motion. Tests of the theory are proposed and evaluated numerically using a two-term "velocity potential." (auth)

30047 (ORO-2434-4) AN EXPERIMENTAL STUDY OF NUCLEAR MODELS. I. DECAY SCHEMES AND NUCLEAR REACTIONS. Progress Report. Sheline, Raymond K. (Florida State Univ., Tallahassee). May 1, 1968. Contract AT(40-1)-2434. 376p. Dep. CFSTI.

Some experimental investigations of nuclear level schemes and structure by nuclear reactions, in which the data were analyzed using the collective model or the shell model, are summarized together with some supporting theoretical studies. Progress in the preparation and spectroscopy of metal carbonyls is also outlined. The publications that resulted from this research are listed; the full text of several papers is included. (D.C.W.)

30048 (PUC-937-307) NUCLEAR PHYSICS PROGRESS REPORT, APRIL 1967–APRIL 1968. (Princeton Univ., N. J.). Contract AT(30-1)-937. 42p. Dep. CFSTI.

A number of investigations of nuclear energy levels by charged-particle reactions and scattering are summarized, together with theoretical studies dealing with nuclear models, nuclear reactions, beta transitions, Coulomb energies, and nuclear stability. Methods for measuring the moments and spins of nuclei, including isomeric

and radioactive nuclei, are reported, as are a number of determinations of nuclear moments and spins by the atomic-beam magnetic resonance technique. Developments in radiation monitoring systems, target chambers, ion sources, and data acquisition systems for the AVF cyclotron are also outlined. (D.C.W.)

30049 (PUC-937-314) ISOTOPE SHIFT. Brown, G. E. (Princeton Univ., N. J. Palmer Physical Lab.). May 1968. Contract AT(30-1)-937. 11p. Dep. CFSTI.

A self-consistent description of the effect of adding a neutron to a nucleus is attempted using the Hartree-Fock formalism with a static, density-independent nucleon-nucleon potential. The form of the interaction is then considered in more detail; specifically, the use of reaction matrix formalism and a density-dependent potential in place of the static, density-independent potential in studied. It is shown that the density dependence of the effective interaction is quite important in the description of the isotope shift. (D.C.W.)

30050 ACCURACY OF CALCULATION OF ONE-PARTICLE STATES OF DEFORMED NUCLEI. Gareev, F. A.; Ivanova, S. P.; Kalinkin, B. N. (Joint Inst. for Nuclear Research, Dubna, USSR). Acta Phys. Pol., 33: 135-40(Jan. 1968). (In Russian).

The precision of the method of calculating the energy and wave functions of one-particle states of deformed axial-symmetrical nuclei was examined. The results of the calculation on both the energy and structure states are in good agreement with data obtained previously with very precise and very cumbersome methods. The method described has great merit. On the one hand, the complex form of the realistic potential, having a diffuse edge, is taken into consideration. This leads to the most consistent determination of the energy levels and wave functions (in particular, their behavior on the boundary and periphery of the nucleus). On the other hand, the method makes possible very rapid calculations, and it permits the wave functions found to be presented in analytical form. This gives it great ease of application. (tr-auth)

30051 AN OPTICAL-MODEL INVESTIGATION OF ELASTIC NEUTRON SCATTERING: LIGHT NUCLEI. Cassola, R. L.; Koshel, R. D. (Ohio Univ., Athens). Nuovo Cim., B, 55: 83-94(May 11, 1968).

The elastic scattering of neutrons from several light nuclei ($A < 20$ amu) was analyzed in terms of a four-parameter optical potential. It has been found that, although this four-parameter potential is adequate for describing neutron scattering from heavy nuclei, it fails to be uniformly applicable to neutron scattering from light nuclei. (auth)

30052 ANGULAR-MOMENTUM DISTRIBUTIONS OF RESIDUAL NUCLEI IN COMPOUND-NUCLEAR REACTIONS. Halpern, I.; Shepherd, B. J.; Williamson, C. F. (Univ. of Washington, Seattle). Phys. Rev., 169: 805-18(May 20, 1968).

A classical vector model is used to determine the changes which occur in the distribution functions for the angular momentum of nuclei when particles and photons are evaporated from these nuclei. Closed-form expressions are derived for angular-momentum distributions after a sequence of evaporations. It is found that at higher excitations one must expect the average angular momentum of a nucleus to decrease by a relatively small amount per evaporation. The mean-square angular momentum will increase or decrease depending on the ratio of the nuclear angular momentum to the equipartition value appropriate to the nuclear excitation. General expressions are given for the angular distributions of the evaporations. Some of the difficulties of applying statistical models to emissions at low excitation energies are briefly discussed. (auth)

30053 ASYMPTOTIC CHANNEL STATES AND MATRIX EQUATIONS IN THE UNIFIED REACTION THEORY. Hahn, Yukap (Univ. of Connecticut, Storrs). Phys. Rev., 169: 794-804(May 20, 1968).

The multidimensional formulation of the unified reaction theory with asymptotic channel states of different cluster compositions is discussed and extended. Modified sets of projection operators and Hermitian orthoprojectors are derived using the channel-mixing operator and it is shown that the Hermiticity of the operators may be an unnecessarily stringent requirement for the formulation of the theory. The simple diagonal form of the orthoprojectors given earlier is shown, however, to be sufficient to construct a reaction theory consistent with the asymptotic boundary conditions if the matrix equations are suitably modified. Based on the many-particle scattering theory, a useful reduction method for the modification of the matrix equations is developed. Application of the method provides a series of sets of coupled equations for the description of direct processes, which contains a sufficient amount of desirable properties in the restricted direct-channel spaces to give consistent solutions. (auth)

30054 ATOMIC NUCLEUS AND ITS MODELS. Revai, Janos. Fiz. Szemle, 18: 14-16(Jan. 1968). (In Hungarian).

Theoretical studies in physics may be classified as "black box" systems, designating theories which attempt to correlate experimental data on the basis of general laws, without attempting to understand the internal dynamics of the process, and as phenomenological theories, based on the analogy with other, well understood areas of physics, yielding ultimately semi-empirical laws. Further development of these approaches lead, in the case of the many-body systems, to the microscopic theory. Nuclear theories cover two broad areas: nuclear structure and nuclear reactions. The influence of the black-box and phenomenological approaches may be followed in the development of theoretical studies in these fields. In nuclear structure, Wigner's supermultiplet theory based on the general invariance, represented the black-box method; the semi-empirical formula of Bethe and Weizsacker, correlating the binding energy, mass number and order number of the nucleus has a phenomenological character. The development of these models, the Bohr-Mottelson theory, pair-interaction theory, superconductivity, Bruckner's nuclear mass, wave function, doorway states, the Bloch-Gillet theory, and the shell model is briefly touched upon. (TTT)

30055 BROKEN O_8 SYMMETRY AND MASS RELATIONS FOR NUCLEI. Bremond, Bernard (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Nucl. Phys., A113: 257-64(1968).

Wigner's SU_4 symmetry group for nuclei has recently been generalized to include pairing interactions. In the resulting O_8 group, mass relations can be derived and checked with experimental data. A gap is defined which is seen to correspond to that observed in real nuclei. (auth)

30056 COLLECTIVE EFFECTS IN GAMOW-TELLER BETA DECAY. Sorensen, Raymond A. (Carnegie Inst. of Tech., Pittsburgh. Univ. of Copenhagen). Ark. Fys., 36: 657-61(1967).

From International Symposium on Why and How Should We Investigate Nuclides Far Off the Stability Line, Lysekil, Sweden. See CONF-660817.

For all but the light nuclei, allowed beta decays are very much retarded from the single particle value (log ft ≈3.5). For Fermi decays, the transition operator $\tau\pm$, only connects neighboring isotopic analog states. Thus a ground state ($T = T_z$) of a nucleus with $N > Z$ is connected by its beta operator only to its analog in the nucleus $N-1$, $Z+1$. The latter state lies above the former by the Coulomb energy so that energetically allowed Fermi decays can occur via the small isotopic spin impurities, which thus explain the slow rate. A similar explanation of the retardation of Gamow-Teller decays is outlined along with some of the consequences of the model. (S.F.L.)

30057 COUPLED-CHANNELS METHOD FOR REARRANGEMENT COLLISIONS. Volkin, Howard C. (Lewis Research Center, Cleveland). Ann. Phys. (N. Y.), 46: 453-93(Feb. 1968).

As shown by Feshbach, coupled-channel equations that describe a reaction can be obtained by means of an open channel projection operator. For a given rearrangement collision, the classification and construction of such operators are developed here from the unifying viewpoint of their projective spaces, which are subspaces of the total Hilbert space of the system. The open-channel projection operators are not unique. But the practical limitations on their choice are made clear when their construction is viewed in terms of the fundamental channel subspaces that arise naturally in the problem. The projectors for the channel subspaces are the basic ones from which the open-channel projectors are constructed. Generalized channel transformation functions supply all the information needed for this purpose. The representative case of the pickup or stripping process is treated. The various possible projection operators that can be obtained in closed form are identified for the two-channel case. These include those given by Feshbach and by Chen and Mittleman, as well as new ones suggested by our methods. In all cases, the extension to the multichannel case is shown to follow easily. The use of projection operators to obtain the coupled equations is discussed, including their application to generalized potential models. The appropriate boundary conditions are also given in each case. (auth)

30058 COUPLING OF THE GIANT MULTIPOLE RESONANCES TO THE SURFACE QUADRUPOLE OSCILLATIONS OF NUCLEI. Stock, H.; Arenhoevel, H. (Univ., Frankfurt am Main). Z. Phys., 212: 83-103(1968).

Within the framework of the hydrodynamic model the exact coupling constants of the coupling of the giant multipole reso-

nances to the surface quadrupole oscillations of nuclei are derived. The differences to former variational calculations are discussed. It is found that the coupling constants for the terms linear in the surface variables are almost the same, whereas the coupling constants for the quadratic terms differ appreciably. The influence on the photon absorption and scattering cross sections of spherical nuclei is discussed. (auth)

30059 DEFORMABILITIES OF NEUTRON-RICH NUCLEI FROM NEW FISSION DATA. Schmitt, H. W. (Oak Ridge National Lab., Tenn.). Ark. Fys., 36: 633-42(1967).

From International Symposium on Why and How Should We Investigate Nuclides Far Off the Stability Line, Lysekil, Sweden. See CONF-660817.

A semi-empirical "bootstrap" calculation, based on recent precise measurements of fission fragment kinetic energies, was carried out to determine relative deformability parameters of even-even fission fragments in a two-spheroid model of the scission configuration. The calculation consists of minimization of the total potential energy V at scission, where V contains the potential energies of deformation of the two fragments and E_c, the mutual Coulomb repulsion at scission. The additional requirement is that $E_c = E_k$, where E_k is the experimental average total fragment kinetic energy. The resulting deformability parameters are self-consistent and follow trends which are consistent with known nuclear structure properties of less neutron-rich nuclei. A strong maximum is exhibited in the region where Z = 50 and N = 82; a broader maximum appears in the region where N = 64. Comparison of the calculated deformation energies with experimentally determined excitation energies indicates the possible existence of equilibrium deformations among neutron-rich nuclei in the mass region from ~80 to ~120 amu. (auth)

30060 DERIVATION OF THE CRANKING EQUATIONS FROM THE KERMAN–KLEIN FORMALISM. Kamlah, A.; Meyer, J. (Technische Hochschule, Munich). Z. Phys., 211: 293-303(1968).

A modified version of the Kerman-Klein method for the description of nuclear rotations is given in terms of generalized density matrices. It is shown that the system of basic equations is free from inconsistencies inherent in the original formulation of Kerman and Klein, and that it is completely equivalent to the cranking equations. To obtain this result from the exact equations of quantum mechanics attention is restricted to the plane rotator model and to the factorization of the generalized two-particle density matrix in a special new way. It is stressed, however, that neither an I^2 spectrum nor a cranking mechanism has been imposed. (auth)

30061 EFFECT OF EXPERIMENTAL RESOLUTION ON THE MEASURED WIDTH OF CROSS–SECTION FLUCTUATIONS. Bizzeti, P. G.; Maurenzig, P. R. (Univ., Florence). Nuovo Cim., B, 55: 171-7(May 11, 1968).

The results of a previous note on the number of maxima and minima in a fluctuating excitation curve have been extended to include the effect of the experimental energy resolution. A close formula is derived for the number of maxima as a function of Γ by assuming a Gaussian distribution for the cross sections which gives a good approximation in all practical cases. Numerical results are presented for the cases of rectangular and Gaussian resolution functions. (auth)

30062 EFFECTIVE VELOCITY-DEPENDENT POTENTIALS FOR USE IN LARGE NUCLEI. Donnelly, I. J. (Univ. of Sydney). Nucl. Phys., A111: 201-8(1968).

The criteria for developing an effective velocity-dependent nucleon-nucleon potential which gives realistic energies for large nuclei are discussed, and two such potentials are constructed. One is successful while the other gives too large values for the surface and symmetry energies. The reasons for the differences are investigated. The potentials are used to find the energy-density relationship for the neutron gas. (auth)

30063 EXCITATION SPECTRA OF EVEN–EVEN NUCLEI OF NON-DEFORMED REGION. Ramamohan, R. V. (Univ. of Agricultural Sciences, Bangalore, India). Indian J. Phys., 41: 779-80(Oct. 1967).

The results of some angular correlation studies of the energy levels of ^{134}Ba, ^{58}Fe, and ^{128}Te are compared with the predictions of various nuclear models. Spin-parity assignments, transition probabilities, and multipolarities are the parameters discussed. (D.C.W.)

30064 EXPERIMENTAL STUDIES OF TIME-DEPENDENT hf INTERACTIONS CAUSED BY AFTER-EFFECTS OF HOLE FORMATION. Baeverstam, U.; Johansson, A.; Gerholm, T. R. (Univ. of Stockholm). Ark. Fys., 35: 451-67(1968).

Present knowledge of the after-effects of hole formation due to internal conversion, electron capture, alpha, and beta decay is briefly reviewed with a particular consideration of the time-dependent hf coupling that is present immediately after the radioactive decay. Three independent experimental methods for the investigation of this hf coupling are described. These are comparison studies of electron-gamma and gamma-gamma directional correlations, magnetic decoupling experiments and time differential directional correlations. A new experimental arrangement was developed, which is briefly described. From experimental studies of two cascades in ^{197m}Hg and ^{207}Pb, respectively, conclusions concerning the strength of the hf coupling were drawn. (Sweden)

30065 FAR-UNSTABLE NUCLEI AND MASS LAWS. Wapstra, A. H. (Instituut voor Kernphysisch Onderzoek, Amsterdam, Oak Ridge National Lab., Tenn.). Ark. Fys., 36: 329-41(1967).

From International Symposium on Why and How Should We Investigate Nuclides Far Off the Stability Line, Lysekil, Sweden. See CONF-660817.

Procedures are described for using and obtaining nuclear mass or binding energy formulas; several of such formulas are discussed. (auth)

30066 FERMI DECAYS. Damgard, Joergen (NORDITA, Copenhagen). Ark. Fys., 36: 651-6(1967).

From International Symposium on Why and How Should We Investigate Nuclides Far Off the Stability Line, Lysekil, Sweden. See CONF-660817.

Possibilities for the study of Fermi transitions with $\Delta T = 0$, 1, and 2 are briefly reviewed. (S.F.L.)

30067 FORMALISM FOR CALCULATION OF NEUTRON-INDUCED GAMMA-RAY PRODUCTION CROSS SECTIONS AND SPECTRA. Howerton, R. J.; Plechaty, E. F. (Univ. of California, Livermore). Nucl. Sci. Appl., 32: 178-83(1968). (UCRL-70734).

A formalism is developed from observable systematics and elementary energetics of nuclear reactions for the calculation of neutron-induced gamma-ray production cross sections and spectra. The calculations are compared with experiments performed at several laboratories. The comparison shows a mean deviation of 18%. (auth)

30068 HARTREE–FOCK CALCULATIONS FOR HEAVY NUCLEI. Bleuler, K.; Petry, H. R.; Schuette, D. (Univ., Bonn). Nuovo Cim., B, 55: 296-8(May 11, 1968).

The Hartree-Fock equations were solved with realistic effective two-body forces for a complete sequence of closed-shell spherical nuclei with A = 16 to 208 in order to obtain a numerical basis for the shell structure. The effective forces were determined by fitting scattering data up to 150 MeV using a Hamada-Johnston-type potential in which the inner part was set equal to zero. Numerical results for the total energies and the energy of the deepest s-state including the second-order contribution of the tensor force are presented. (D.C.W.)

30069 IMAGINARY PART OF THE OPTICAL POTENTIAL FOR NEUTRON SCATTERING ON HEAVY NUCLEI. Franke, E.; (Zentralinstitut fuer Kernforschung, Dresden); Elk, K.; Macke, W. Ann. Phys. (Leipzig), 7: 214-19(1967). (In German).

The optical potential in the sense of the Brueckner approximation was formulated for neutron scattering by heavy nuclei. The imaginary part of the optical potential was calculated independently using the pulse-dependent nucleon–nucleon force, and satisfactory agreement was obtained with experimental results. (tr-auth)

30070 INTERMEDIATE STRUCTURE IN A TWO-CHANNEL MODEL. Lejeune, A.; Mahaux, C. (Univ., Liege). Nucl. Phys., A113: 272-88(1968).

A two-channel model in the framework of the shell-model approach to the theory of nuclear reactions was constructed. One doorway state in channel c and many states which are coupled to channel c were included. This corresponds to the physical situation encountered in some inelastic scattering processes or in the (p,n) reaction at the isobaric analogue resonances. The analytic expressions of the shape-elastic part of the elastic scattering cross section in each channel were computed. The distribution of the fine structure parameters is given. These theoretical laws are compared with the values extracted from some numerical examples. The compound-elastic part of the cross section was calculated. Both the shape- and the compound-elastic parts in channel c display an intermediate structure resonance. In channel c′, only the compound-elastic part is affected by the doorway state. (auth)

30071 INTERPRETATION OF THE ISOTROPIC GAMMA-RAY ANGULAR DISTRIBUTION FOR A FINAL STATE OF SPIN ½. Taras, P. (Univ., Montreal). Nucl. Instrum. Methods, 62: 117-18(June 1, 1968).

Values of the spin of the upper state and of the mixing ratio of the decay γ rays consistent with an isotropic angular distribution of the γ rays leading to a final state of spin $\frac{3}{2}$ are presented. The usefulness of a linear polarization measurement under these conditions is discussed. (auth)

30072 INTRODUCTORY REMARKS ON MASS FORMULAE. Swiatecki, W. J. (Univ. of California, Berkeley). Ark. Fys., 36: 325-7(1967).

From International Symposium on Why and How Should We Investigate Nuclides Far Off the Stability Line, Lysekil, Sweden. See CONF-660817.

Brief comments are given on the relation of the subject of nuclear masses to the nuclear Hamiltonian, and hence to the subject of nuclear deformabilities. Also discussed is the relation of microscopic and macroscopic calculations of nuclear masses and deformabilities, or the relation of shell-model and liquid-drop calculations. (S.F.L.)

30073 ISOSPIN AND NUMBER-CONSERVING TREATMENT OF PAIRING CORRELATIONS IN NUCLEI. Campi, X.; Vucetich, H.; Jean, M. (CNRS, Orsay, France). Nuovo Cim., B, 55: 185-98(May 11, 1968).

A previous study of the pairing interaction between identical particles by means of the equations of motion is extended to the case of unlike nucleons interacting through a charge-independent force. By comparison with the Hecht model for which exact numerical results are available, results are seen to be a compromise between those of the BCS and the present Lipkin-Nogami methods. (auth)

30074 ISOTOPE SHIFT OF THE NUCLEAR POTENTIAL RADIUS. Sood, P. C.; Leighton, H. G. (Univ. of Alberta, Edmonton). Nucl. Phys., A111: 209-15(1968).

The variation of the potential radius for the isotopes of an element is studied based on the symmetry dependence of the potential well depth. The potential parameters of a non-local Woods–Saxon potential are determined by fitting to the experimental proton separation energies. It is shown that the assumption of the validity of $A^{\frac{1}{3}}$ dependence for the potential radius leads to a symmetry term of the wrong sign. An order of the magnitude estimate of the symmetry term is sufficient to establish the anomalous isotope shift of the proton potential radius. Results of the calculations for Ti and Xe isotopes are presented as illustrations. The study also leads to some guidelines for proper representation and determination of the symmetry term in the potentials. (auth)

30075 LINEARIZATION OF THE PAIRING HAMILTONIAN. II. Chasman, R. R. (Argonne National Lab., Ill.). Phys. Rev., 169: 782-8(May 20, 1968).

A single-intermediate-state (SIS) approximation is developed for dealing with the pairing Hamiltonian. With the aid of this approximation, expressions are obtained for the ground-state energy of an $(n + 2)$-particle system in terms of the ground-state wave function of the n-particle system. Results are obtained for excited-state energies in the n- and $(n \pm 1)$-particle systems. Numerical comparisons are made with reliable results obtained with other techniques. It is observed that the results obtained from the SIS approximation are quite accurate. The SIS approximation is also used to point out one source of error inherent in the BCS solution of the pairing problem. (auth)

30076 MICROSCOPIC APPROACH TO THE SEMI-EMPIRICAL MASS FORMULA. Bauer, M.; Canuto, V. (Univ. Nacional Autonoma de Mexico, Mexico City. Comision Nacional de Energia Nuclear, Mexico City. Centro de Investigacion y de Estudios Avanzados del Instituto Politecnico Nacional, Mexico City). Ark. Fys., 36: 393-412(1967).

From International Symposium on Why and How Should We Investigate Nuclides Far Off the Stability Line, Lysekil, Sweden. See CONF-660817.

It is shown that the ground state energy of nuclei as given in an extended shell model framework, can be suitably rewritten so as to exhibit the structure of the Bethe–Weizsäcker semi-empirical mass formula. Additional terms are predicted, of which the most important is a positive term of the form $a_5 A^{-\frac{5}{3}}$ (binding energy per nucleon). All the coefficients, except the volume one, depend on deformation and/or shell filling, being larger for deformed nuclei or away from closed shells. Inclusion of the new term and the above variations, results in producing larger binding energies in the vicinity of magic numbers, and in reproducing the deformation regions, improving, therefore, on the usual semi-empirical formula. Furthermore, it is shown that, taking into account the non-locality of the Hartree–Fock single particle potential, one obtains good values for the binding energies using shell model parameters taken from nuclear structure calculations. (auth)

30077 MICROSCOPIC CALCULATIONS OF THE NUCLEON SHELL EFFECTS IN THE DEFORMATION ENERGY OF NUCLEI. Strutinskii, V. M. (Kurchatov Atomic Energy Inst., Moscow). Ark. Fys., 36: 629-32(1967).

From International Symposium on Why and How Should We Investigate Nuclides Far Off the Stability Line, Lysekil, Sweden. See CONF-660817.

A brief report is given on some of the results of calculations of shell corrections to the liquid-drop-model nuclear energy. Figures are given for equilibrium deformations of nuclei; pairing energy gap for the positive equilibrium deformations; sum over protons and neutrons of the shell nucleon level densities at the Fermi energy; calculated energy difference between the equilibrium oblate and prolate nuclear shapes; calculated corrections to the liquid-drop-model spherical nuclear masses; and deformation energies for some heavy nuclei, including ^{230}Th, ^{238}U, ^{240}Pu, ^{250}Cf, ^{258}No, ^{260}104, ^{268}108, ^{276}112, ^{288}116, and ^{310}126. (S.F.L.)

30078 MICROSCOPIC THEORY OF NUCLEAR COLLECTIVE MOTION. Holzwarth, G. (Technische Hochschule, Munich). Nucl. Phys., A113: 448-60(1968).

The mutual coupling of vibrational states as a consequence of rotation is treated with a modified Jancovici–Schiff formalism while the structure of the states is determined according to the vibrating potential model. The rotations are treated in the cranking approximation. (auth)

30079 MORSE POTENTIAL MEDIATION OF OFFSHELL $^1S_0$ PROTON–PROTON SCATTERING. Brolley, John E. (Los Alamos Scientific Lab., N. Mex.); Morrison, L. Kent. Contract W-7405-eng-36. Progr. Theor. Phys. (Kyoto), 39: 540-1(Feb. 1968). (LA-DC-9177).

It was recently shown that offshell proton-proton scattering, accompanied by photon emission, may be expected to have a minimum in the few hundred kilovolt region. This effect arises from the destructive interference of the offshell electric and strong interaction amplitudes. The problem of discriminating against various types of potentials from a study of the interference region is considered. (L.B.S.)

30080 NEW REGIONS OF DEFORMATION. Johansson, Sven A. E. (Lund Inst. of Tech., Sweden). Ark. Fys., 36: 599-607 (1967).

From International Symposium on Why and How Should We Investigate Nuclides Far Off the Stability Line, Lysekil, Sweden. See CONF-660817.

Besides the three well-known regions of nuclear deformation, there should exist other regions where the nuclei have a permanent deformation. The condition for the occurrence of such a region is that the nucleon numbers are sufficiently far away from the magic numbers. In most cases these regions are so far off the stability line that the nuclei they contain are very unstable or nonexistent. A brief description is given of calculations aimed specifically at finding new regions of deformation. The method is based on a semi-empirical approach with the deforming force calculated from the single particle level diagram. It is concluded that any extended new regions of deformation situated so close to the line of beta stability as to be accessible to experimental investigation cannot be expected. There appear to be two small regions in which one can hope to find the new deformed nuclei. (S.F.L.)

30081 NUCLEAR DEFORMABILITIES IN THE RARE-EARTH AND ACTINIDE REGIONS WITH EXCURSIONS OFF THE STABILITY LINE AND INTO THE SUPER-HEAVY REGION. Gustafson, C.; Lamm, I. L.; Nilsson, B.; Nilsson, S. G. (Lund Inst. of Tech., Sweden). Ark. Fys., 36: 613-27(1967).

From International Symposium on Why and How Should We Investigate Nuclides Far Off the Stability Line, Lysekil, Sweden. See CONF-660817.

An improved parameter fit for the deformed nuclear potential is made. A few examples of total-intrinsic-energy surfaces calculated on the basis of single-particle energies corresponding to this potential with pairing and Coulomb energies included are given as a function of Y_{20} and Y_{40} distortions. Satisfactory equilibrium deformations are obtained. The tendency for the formation of a neckline near the fission point is well borne out in the calculations. (auth)

30082 NUCLEAR SEPARATION ENERGIES AND THE POSSIBILITY OF EXTRAPOLATIONS. Bleuler, K.; Beiner, M.; Erkelenz, K.; Schneider, R. (Univ., Bonn). Ark. Fys., 36: 385-92 (1967).

From International Symposium on Why and How Should We Investigate Nuclides Far Off the Stability Line, Lysekil, Sweden. See CONF-660817.

Nuclear separation energies are investigated from the micro-

scopic viewpoint using the principles of shell structure and the BCS method (or Bogoliubov transformation) for the pairing corrections. The main goal of the work is to calculate these energies as well as other nuclear properties as functions of the nucleon numbers N and Z and to compare these functions graphically with the corresponding empirical diagrams. The region of spherical structure ($40 < A < 160$, $A \sim 208$) was considered. Empirical effective nuclear forces, determined explicitly from nucleon–nucleon scattering data, are used to calculate the pairing effects which play a decisive role in the behavior of nuclear separation energies. The parameters used in the calculations are all related to the phenomenological expression of the underlying spherical nuclear potential. They were determined from rather general nuclear properties which are not directly related to the special behavior of separation energies. The main result of the work is a direct evaluation of the absolute strength of pairing effects as functions of N and Z. Only a small number of phenomenological parameters which have the same value over all the periodic table was used for the model to reproduce the rather complicated and characteristic systems of curves of the empirical data. (S.F.L.)

30083 PARITY MIXING IN SINGLE-PARTICLE ORBITALS AND COEFFICIENTS OF FRACTIONAL PARENTAGE. Boffi, S. (Univ., Pavia, Italy). Nuovo Cim., B, 55: 283-5(May 11, 1968).

Formulas for coefficients of fractional parentage are derived taking into account parity mixing in single-particle orbitals. The formula for the coefficients of fractional parentage is simplified for the case of three identical particles; the result of the standard shell model is obtained. (D.C.W.)

30084 POSSIBLE TESTS FOR THE VIOLATION OF PARITY AND TIME-REVERSAL INVARIANCE IN NUCLEI. Szymanski, Z. (California Inst. of Tech., Pasadena). Contract AT(04-3)-63. Nucl. Phys., A113: 385-94(1968).

Consequences of the assumption that time-reversal (T) invariance is weakly violated together with the weak parity (P) violation in the nucleus are investigated in connection with the observed $K_2^0 \to 2\pi$ decay. The odd-T terms in the nucleon–nucleon effective force are calculated, and their contribution to the average nuclear potential are estimated. Various possible electromagnetic nuclear transitions are considered that can be used as tests for the simultaneous violation of T- and P-invariance in the nucleus. (auth)

30085 PROBLEM OF THREE PARTICLES WITH A MOMENTUM DIFFERENT FROM ZERO INTERACTING WITH A NON-LOCAL FACTORIZING POTENTIAL. Chilashvili, G. A. (Tbilisi Univ., USSR). Soobshch. Akad. Nauk Gruz. SSR, 48: 299-303(1967). (In Russian).

The general case of a two-particle interaction which is characterized by any momentum value is an important problem in studying the cluster structure of the nucleus, where it is possible to consider a number of light nuclei in the form of three independent substructures. The equations of Faddeev are widely used in studying the three-particle problem, especially in the case of a non-local factorizing potential, where numerical integration of the equations is possible up to the end. The solution of the Faddeev equation is presented in the form of the sum of three functions, and these functions are solved in explicit form. (TTT)

30086 ROLE OF THE REAL NUCLEAR AND COULOMB PHASES IN ELASTIC DIFFRACTION SCATTERING. Abul-Magd, A. Y. (Atomic Energy Establishment, Cairo); Simbel, M. H. Nucl. Phys., A111: 216-24(1968).

The role of the real nuclear and Coulomb phase shifts in elastic scattering of strongly absorbed projectiles is investigated. It is shown that the introduction of the Coulomb phases equally raises the minima, while the introduction of the real nuclear phases raises some minima and reduces others. After including both the real nuclear and Coulomb phases, detailed agreement between the theory and experiment was achieved. (auth)

30087 REAL CENTRAL PART OF THE PROTON OPTICAL MODEL POTENTIAL. Greenlees, G. W.; Pyle, G. J.; Tang, Y. C. (Univ. of Minnesota, Minneapolis). Phys. Lett., 26B: 658-9 (Apr. 29, 1968).

The recent results of Perey and Perey on the analysis of 11-MeV proton differential elastic scattering and polarization data are shown to have a simple interpretation, not requiring an energy-dependent geometry as suggested by these authors. (auth)

30088 ROLE OF UNITARITY IN DIFFRACTIONAL REACTIONS. Schiffrer, Giuliano (Univ., Catania, Italy). Nucl. Phys., A113: 367-75(1968).

A diffractional reaction is defined by requiring that in its angular distribution the interference term between any pair of partial wave amplitudes of fixed modulus and given angular momentum is maximum. Some sufficient conditions for a binary reaction involving spinless particles to be diffractional are given, using only unitarity and symmetry of the S-matrix. One of these conditions is satisfied if a suitably defined strong absorption holds in the initial and in the final channel and if the partial reaction cross sections are equal in both channels for each angular momentum. The cases of diffractional reactions involving nonvanishing spins and of a reaction between spinless heavy ions are briefly discussed, and tests for diffraction are proposed. (auth)

30089 SEMIEMPIRICAL MASS FORMULA FOR DEFORMED NUCLEI. Johansson, S. A. E.; Wene, C.-O. (Lund Inst. of Tech., Sweden). Ark. Fys., 36: 353-60(1967).

From International Symposium on Why and How Should We Investigate Nuclides Far Off the Stability Line, Lysekil, Sweden. See CONF-660817.

A semiempirical mass formula is developed for nuclei in the deformed and near-deformed (intermediate) regions. The level densities in these regions show a smooth variation with the mass number and a statistical description which is the basis of the mass formula should be applicable. In order to describe as many nuclides as possible in the intermediate region between strongly deformed and spherical nuclei a simple shell correction term is added. Experimental values are used for the deformation. The correlation which is obtained between mass and deformation is so strong that any smoothed values of the deformation would result in errors in the predicted mass, and for this reason only even–even nuclei are treated. The formula is a function of Z, A, and ρ where ρ is the experimentally determined deformation. It describes, with only two free parameters, deformed and near-deformed nuclei in the rare earth and actinide regions with a root mean square deviation of 0.27 mMU or a most probable error of 0.17 mMU. The deviations seem to be fully explained by single particle effects and experimental errors. (S.F.L.)

30090 SHELL MODEL APPROACH TO NUCLEAR MASSES AND SOME PROBLEMS CONNECTED WITH EXTRAPOLATION. Zeldes, Nissan (Hebrew Univ. of Jerusalem. Univ. of Copenhagen). Ark. Fys., 36: 361-83(1967).

From International Symposium on Why and How Should We Investigate Nuclides Far Off the Stability Line, Lysekil, Sweden. See CONF-660817.

A shell model mass formula is briefly described and some of the experimental evidences concerning the magic numbers are examined. Comments are given on some problems arising in connection with the application of mass formulas to calculate unknown masses. (auth)

30091 SHELL-MODEL METHOD FOR THE SPLITTING OF RESONANCE MULTIPLETS. Vincent, C. M. (Weizmann Inst. of Science, Rehovoth, Israel). Nucl. Phys., A113: 249-56(1968).

It is shown that the usual form of the shell model cannot apply to the calculation of resonance energies, because a resonance energy is not stationary with respect to variation of a trial bound state. Two simple theories of the first-order perturbation of resonance energies are given and are applied to the splitting of resonance multiplies. The results are similar in form to those of ordinary bound-state perturbation theory, but the (infinite) norm of the zero-order resonant state is replaced by a suitable effective norm related to the resonance width. Barrett's harmonic oscillator shell-model calculations on the resonances of the mass-four system are discussed from this point of view. It is concluded that at least the width of the zero-order resonance must be known in order to correct for the unbound nature of the states. (auth)

30092 SMOOTH NUCLEON-NUCLEON INTERACTIONS AND MESON THEORY. Desgrolard, P.; Pearson, J. M.; Saunier, G. (Univ. of Montreal). Can. J. Phys., 46: 963-9(Apr. 15, 1968).

Tabakin and Davies have shown that it is possible to fit the singlet-state nucleon-nucleon data with a potential that is smooth enough to give very small second-order terms in an ordinary perturbation–theoretic treatment of nuclear matter. However, their potential is unrealistic in that the requirements of meson theory are in no way satisfied in the long-range region. It is shown here that a potential whose long-range part conforms to the OBEP of Bryan and Scott can still be made to fit the phase shifts without increasing significantly the second-order terms. Thus, with meson theory being incapable of making an unequivocal statement about the short-range region, it will only be by resorting to the experimental evidence for short-range correlations in nuclei that one will be able to resolve the question as to whether or not an interaction as smooth as the one considered here can be regarded as "real" rather than merely "effective." In any event,

the existence of such correlations can not be inferred from the singlet nucleon-nucleon data. (auth) (Canada)

30093 SPECTROSCOPIC FACTORS FOR TWO-NEUTRON TRANSFER REACTIONS IN VIBRATIONAL NUCLEI. Gyarmati, B.; Sawicki, J. (International Centre for Theoretical Physics, Trieste, Italy). Phys. Rev., 169: 966-73(May 20, 1968).

The spectroscopic factors of two-nucleon transfer reaction amplitudes are calculated with the microscopic theories known as the quasiparticle Tamm-Dancoff (QTD) and "second" Tamm-Dancoff (QSTD) methods. The latter theory describes vibrational states in terms of zero-, two, and four-quasiparticle (qp) excitations. The theory is applied to study (p,t) and (t,p) reactions in even tin isotopes. All the important lowest-lying states of these isotopes of both even and odd parity are included in the analysis. The QTD and QSTD eigenvectors correspond to several different residual interaction potentials. One of these potentials is the realistic potential of Tabakin renormalized for core polarization. The four-qp correlations cause a quite considerable reduction of the spectroscopic factors relative to those of the QTD theory. These factors are also appreciably sensitive to the effective nuclear force assumed. (auth)

30094 SPECTROSCOPIC INFORMATION FROM THE EXCITATION OF ISOBARIC ANALOGUE STATES. Bondorf, J. P. (Univ. of Copenhagen). Ark. Fys., 36: 663-5(1967).

From International Symposium on Why and How Should We Investigate Nuclides Far Off the Stability Line, Lysekil, Sweden. See CONF-660817.

For neutron-rich nuclei (Z,N) the isobaric analog states of the low excited states of the nucleus (Z, N + 1) are observed as resonances in the cross sections of proton-induced reactions. The same low excited states of (Z, N + 1) can be excited in the (d,p) stripping of (Z,N). Proton scattering through analog resonances and (d,p) stripping are briefly discussed as methods for obtaining spectroscopic information for nuclei which have one neutron more than the target nucleus. (S.F.L.)

30095 SPHERICAL AND MAGIC NUCLEI FAR FROM STABILITY. Sorensen, Raymond A. (Carnegie Inst. of Tech., Pittsburgh, Niels Bohr Inst., Copenhagen). Ark. Fys., 36: 585-91(1967).

From International Symposium on Why and How Should We Investigate Nuclides Far Off the Stability Line, Lysekil, Sweden. See CONF-660817.

The possibility of producing new spherical and magic nuclei far from the line of stability is briefly discussed as a means for extending present knowledge of nuclear structure and for broadening the area of the Z – N plane of known nuclear properties. (S.F.L.)

30096 SPIN-QUADRUPOLE FORCES AND COLLECTIVE STATES IN DEFORMED NUCLEI. Pyatov, N. I. (Joint Inst. for Nuclear Research, Dubna, USSR). Ark. Fys., 36: 667-80(1967).

From International Symposium on Why and How Should We Investigate Nuclides Far Off the Stability Line, Lysekil, Sweden. See CONF-660817.

A new type of collective excitations in deformed nuclei is considered, which is due to spin – quadrupole residual interactions between nucleons. The energy of the collective states is found using the method of approximate second quantization. Quadrupole as well as spin-quadrupole interactions are taken into account simultaneously. The appearance of a second 0^+ and a second 2^+ collective state below the energy of the two-quasi-particle excitations is predicted. The decay properties and the structure of the collective states are studied. The energies and transition probabilities of the 0^+ and the 2^+ states are calculated for nuclei in the region $150 \leq A \leq 174$. (auth)

30097 SYNTHESIS OF NUCLEI IN THE REGION OF Z = 126 AND N = 184. Sikkeland, Torbjorn (Univ. of California, Berkeley). Ark. Fys., 36: 539-52(1967).

From International Symposium on Why and How Should We Investigate Nuclides Far Off the Stability Line, Lysekil, Sweden. See CONF-660817.

The possibility of producing nuclei in the region of the hypothetical double shells at Z = 126 (or Z = 114) and N = 184 from interactions between complex nuclei is discussed. This demands the use of ions heavier than Ar which are not readily available at the present time. The estimation of the cross sections for the production of these super-heavy nuclei therefore implies an extrapolation of experimental results obtained with Ar and lighter ions. Three reaction schemes available are grazing or multi-nucleon transfer, fusion–fission or compound nucleus formation followed by fission, and compound nucleus formation followed by neutron evaporation. The estimation of cross sections for these processes is investigated. (S.F.L.)

30098 SYSTEMATICS OF MUON CAPTURE IN AN INDEPENDENT-PARTICLE SHELL MODEL. Bogan, A. Jr. (Case Western Reserve Univ., Cleveland). Nucl. Phys., B5: 431-50(1968).

The total muon capture rate was calculated in a closure approximation for a large number of heavy nuclei. The nuclear model chosen is that of A independent particles (Z protons and N neutrons) in the ground state of an infinite spherical well potential. This model correctly reproduces the low neutrino momentum behavior deduced by Foldy and Walecka but leads to values of the total capture rate in disagreement with experiment. The values predicted for the weak interaction coupling constants assuming reasonable values for the average momentum of the emitted neutrinos are about two-thirds of the conventional values or, if one accepts the conventional coupling constants, the necessary neutrino momentum is found to be about 10% less than one would expect. The possible causes of this and previous discrepancies are discussed, and it is concluded that difficulties associated with nuclear physics (the closure approximation and the choice of a proper shell-model potential and an appropriate average neutrino momentum) are the most likely sources of error. The effect of the radial variation of the muon wave function on the capture rate is examined closely and found to be less than 10% for all nuclei. (auth)

30099 THE EFFECT OF THE PAULI PRINCIPLE ON THE ELECTRIC QUADRUPOLE EFFECTIVE CHARGE. Hamamoto, I. (Univ. of Copenhagen); Molinari, A. Phys. Lett., 26B: 649-51(Apr. 29, 1968).

The effective charges of the protons outside the closed shell Z = 28 are calculated with G-matrix elements of the free nucleon-nucleon potential, including an approximate estimate of the effect of the exclusion principle. (auth)

30100 THE MEAN SQUARE RADIUS OF NUCLEAR MATTER AND SPECTROSCOPIC FACTORS FROM THE DWBA. Sharpey-Schafer, J. F. (Univ. of Liverpool). Phys. Lett., 26B: 652-4(Apr. 29, 1968).

It is noted that the reformulated optical model of Greenlees, Pyle, and Tang, which enables the mean square radius of a nucleus to be measured, can be used to determine the radial distribution of the single-particle wave functions of the captured nucleon in stripping reactions. Using these wave functions in the DWBA, spectroscopic factors can be determined that are very insensitive to the parametrization of the potential used to generate the bound state wave functions. (auth)

30101 THE NUCLEAR LEVEL DENSITY AT 20 MeV EXCITATION ENERGY. Braga-Marcazzan, G. M.; Milazzo-Colli, L. (CISE, Milan, Univ., Milan). Energ. Nucl. (Milan), 15: 186-97(Mar. 1968).

The experimental values of the nuclear level width, obtained from the analysis of the statistical fluctuations in the excitation functions of nuclear reactions, are collected and are compared with the predictions of the statistical model of nuclear reactions. From that comparison, information about the nuclear level density at 20-MeV excitation energy of the compound nucleus can be obtained; in particular the parameter (a) of the level density function is obtained and is compared with the known values at lower excitation energy. (auth)

30102 THEORETICAL ANALYSIS OF 30 MeV PROTON INELASTIC SCATTERING. Fulling, S. A.; Satchler, G. R. (Oak Ridge National Lab., Tenn.). Nucl. Phys., A111: 81-99(1968). (ORNL-P-3569).

Data for the inelastic scattering of 30 MeV protons from various nuclei are analyzed using the collective-model interaction and the distorted-wave approximation. The real, imaginary, spin-orbit and Coulomb parts of the potential are all deformed. The deformation parameters extracted are in good agreement with those obtained from other measurements. A microscopic description of the scattering from ^{40}Ca is also discussed. (auth)

30103 UNIFIED THEORY OF ALPHA DECAY. Harada, Kichinosuke (Japan Atomic Energy Research Inst., Tokyo); Rauscher, Elizabeth A. Phys. Rev., 169: 818-24(May 20, 1968). (UCRL-70434(Rev.1)).

A new theory of α decay is presented in which the nuclear-radius parameter is not used explicitly. An expression is derived—similar to the one in Feshbach's unified reaction theory, and based on the time-dependent perturbation method—which overcomes the inadequacies of previous α-decay theories. It is pointed out that the new decay formula makes it possible to calculate even the absolute value of the decay rate. In this theory, the α-decay process is interpreted as the transition which is caused by the difference between four times the nucleon-nucleus and α-nucleus potentials. The method of numerical calculation is illustrated for the case of a simple α decay. (auth)

30104 UPPER BOUND TO THE GROUND-STATE ENERGY OF N-BODY SYSTEMS AND CONDITIONS ON THE TWO-BODY POTENTIALS SUFFICIENT TO GUARANTEE THE EXISTENCE OF MANY-BODY BOUND STATES. Calogero, F.; Simonov, Yu. A. (Inst. of Theoretical and Experimental Physics, Moscow). Phys. Rev., 169: 789-93(May 20, 1968).

Simple conditions on the two-body potentials which guarantee that at least one bound state exists when N particles interact pairwise with such potentials are obtained. The same approach also yields an upper bound to the energy of the N-body ground state. (auth)

30105 VELOCITY-DEPENDENT INTERACTIONS IN MASS-14 NUCLEI. Freed, N.; Ostrander, P. (Pennsylvania State Univ., University Park). Nucl. Phys., A111: 63-80(1968).

The non-local Tabakin interaction is applied to a shell-model calculation of ^{14}C and ^{14}N. In one approach, the ground and low-lying states are considered to arise from the configuration p^{-2}; in another, configuration mixing in the 2s-1d shell is allowed but is restricted to a closed ^{12}C core. In both calculations, second-order contributions to the t-matrix are taken into account in the plane-wave approximation. The low-lying spectra and $^{14}C \rightarrow {}^{14}N$ beta-decay are studied. Calculations are carried out for ^{18}O and ^{18}F and compared with results obtained from the hard-core Hamada-Johnston interaction. (auth)

30106 VIOLATION OF SPACE PARITY IN NUCLEAR ELECTROMAGNETIC TRANSITIONS. Belyakov, V. A. Zh. Eksp. Teor. Fiz., 54: 1162-71(Apr. 1968). (In Russian).

The effect of violation of P-parity in nuclear electromagnetic transitions on the polarization and resonance absorption of γ radiation is analyzed. Expressions are obtained for the polarization of individual Zeeman components of the radiation, the latter being a mixture of multipoles of different space parity. Formulas are presented which describe the resonance absorption of such radiation. The mixtures E(1)–M(1), E(2)–M(2), E(2)–E(1), and M(2)–M(1) are analyzed in detail. (auth)

30107 WHERE CAN WE EXPECT NEW ALPHA ACTIVITIES IN THE REGION BELOW A = 200? Siivola, Antti (Univ. of Helsinki). Ark. Fys., 36: 413-18(1967).

From International Symposium on Why and How Should We Investigate Nuclides Far Off the Stability Line, Lysekil, Sweden. See CONF-660817.

Experimental information on alpha activities below A = 200 is briefly summarized and the alpha-decay energies compared with those given by mass formulae. Boundaries are estimated for regions where alpha-branching ratios should be large enough to permit the observation of alpha decay and where alpha half-lives are long enough so that well-established experimental techniques can be used. (auth)

30108 EFFECTS OF THE FEINGOLD THREE-BODY VECTOR OPERATOR IN THE LEVEL STRUCTURE OF THE NUCLEAR 1p SHELL. Hill, James Roger. Lawrence, Kan., Univ. of Kansas, 1967. 125p.

Thesis.

The second-order effects of the tensor operator, known to be important in explaining the $^7Li/^{15}N$ doublet splitting ratio, were investigated for the natural-parity states of the nuclear 1p shell. The shell-model Hamiltonian was assumed to contain both one and two-body scalar and vector forces, a two-body tensor force, and the Feingold three-body vector force. The $1p_{\frac{1}{2}}$ and $1p_{\frac{3}{2}}$ orbitals were assumed to have constant size parameter. $(1p)^{A-4}$ configuration functions were taken as basis. The LS reduced matrix elements of the Feingold three-body operator, for $(1p)^{A-4}$ basis functions, were shown to be functions of five parameters. The independent, lowest-configuration reduced matrix elements of the one and two-body operators give rise to 13 additional parameters. The Hamiltonian matrices of the 1p shell nuclei were calculated by the coefficient of fractional parentage chain method. The eigenvalues of the Hamiltonian were fitted, as functions of 18 parameters, to the low-lying, alpha-stable natural-parity states of the 1p shell. The resulting spectra have an RMS deviation from experimental values of 0.39 MeV. Alpha-unstable states are poorly predicted. The conclusion was drawn that the second-order tensor effects are important in explaining the nuclear shell model. (Disser. Abstr.)

30109 VOZBUZHDENNYYE SOSTOYANIYA ATOMNYKH YADER. (Excited States of Atomic Nuclei). Davydov, Aleksandr Sergeevich. Moscow, Atomizdat, 1967. 262p.

The monograph presents the phenomenological theory of the excited states of atomic nuclei. It is shown that the energy level of the excited nuclei and the probability of electromagnetic transition in even-even, odd, and odd-odd nuclei depend substantially upon the shape of the nuclei in the initial state (spherical or nonspherical) and their deformability. The deformability parameter appears to be an important characteristic of the nuclei; its value is determined by comparison of theoretical and experimental results. Knowledge of lateral and longitudinal deformability makes it possible to estimate spin and energy of excited states as well as the probability of transition from one state to another. Computed results are presented in the form of tables and graphs, which make possible further comparisons of theoretical values with experimental results. For greater clarity, the computations in the monographs are elaborated with a number of details; and mathematical appendices are added. (ATD)

30110 WAVE FUNCTIONS FOR ODD-ODD DEFORMED NUCLEI. Hess, Charles Thomas. Athens, Ohio, Ohio Univ., 1967. 154p.

Thesis.

The aim of the dissertation is to propose and test a theoretical model for deformed odd-odd nuclei. It is an extension of the existing theories for odd-odd nuclei which is due to Newby, Pineo and Picard, and Struble. It is also intended to be an extension to the testing of the unified model of Mottelson and Nilsson, since their work was limited to odd-even and even-odd nuclei. Furthermore, it is a test of the form factors and exchange strengths of residual interactions. Although the model is applicable to the strongly deformed regions $A \simeq 25$, $150 \leq A \leq 180$, and $A \simeq 225$, testing of the model was done for the rare earth region, $150 \leq A \leq 180$. The testing is further restricted to nuclei with at least two clearly defined band heads of experimental data, both in the odd-odd nucleus claculated and in the odd-even and even-odd nuclei needed for the calculations. The nuclei satisfying these conditions are ^{166}Ho, ^{166}Tm, ^{170}Lu, ^{172}Lu, ^{174}Lu, and ^{176}Lu. Although Yukawa, square well and exponential form factors are possible in the residual interaction, only the Gaussian is used. Although any of the standard exchange mixtures may be done, only spin-spin exchange of the form of Talmi's odd-odd force is done. The calculations are done numerically on a computer and the interaction parameters are fitted to the experimental data for the above mentioned odd-odd nuclei. The procedure was the same as that of Newby, Pineo and Picard, and Struble for the rotational and particle sections of the model. The odd-proton and odd-neutron wave functions described by the Nilsson model were coupled outside a deformed core by Gallagher-Moszkowski coupling. These wave functions together with eigenfunctions of a rigid top were symmetrized in direct product to form the basis for the calculation. Then the remainder of rotation particle terms in the rotational Hamiltonian and the residual interaction between the neutron and proton were treated as perturbation terms. The residual interaction was calculated by the method of Brody and Moshinsky to allow the greater freedom in choice of the form factors. Matrices of a given spin and parity were calculated on an IBM 360/44 computer by using all of the applicable basis states which could contribute. The numerical matrices were then diagonalized. The resulting energies were compared with experimental energies using a least square error criterion which was minimized by varying the residual interaction parameters. The results were shown for a standard set of parameters and for the fitted parameters and compared with the experimental data. The conclusions are that the fitted parameters are better than the standard set in every case. Newby's odd-even shift for K = 0 bands is not fitted using either the standard set of parameters or the fitted set of parameters including only spin-spin exchange. The form of the final set of levels was correct in spin order and spacing and in band head position within 200 keV. Moment of inertia shifts, predicted by Newby and due to the residual interaction and rotation particle coupling were observed. Further extensions with different form factors, more extended parameter fitting, and different exchange mixtures were suggested by the results. Calculations of further properties such as transition rates, magnetic moments, and beta transition rates are also possible using the fitted wave functions. (Disser. Abstr.)

30111 PROCEEDINGS OF THE INTERNATIONAL SYMPOSIUM ON WHY AND HOW SHOULD WE INVESTIGATE NUCLIDES FAR OFF THE STABILITY LINE, LYSEKIL, SWEDEN, AUGUST 21–27, 1966. Forsling, W.; Herrlander, C. J.; Ryde, H. (eds.). Ark. Fys., 36: 1-686(1967). (CONF-660817).

A separate abstract was prepared for 64 of the 73 papers presented. Abstracts of 9 papers have appeared previously in NSA. These papers are listed under CONF-660817 in the cumulative report number index. (C.E.S.)

For abstracts of individual papers see: 27890, 28027, 28028–28030, 28127, 28128, 28164, 28261, 28803, 29165, 29795, 29796, 29844, 29912, 29913, 29923, 29925, 29943, 29949, 29956, 29969, 29994, 29995, 30004, 30007, 30019, 30021–30023, 30025–30034, 30038, 30056, 30059, 30065, 30066, 30072, 30076, 30077, 30080–30082, 30089, 30090, 30094–30097, 30107, and 30112–30117.

30112 INTRODUCTION TO THE LYSEKIL SYMPOSIUM, 1966. Bergstroem, Ingmar (Research Inst. for Physics, Stockholm). Ark. Fys., 36: 3-8(1967).

From International Symposium on Why and How Should We Investigate Nuclides Far Off the Stability Line, Lysekil, Sweden. See CONF-660817.

The bases for the interest in unstable nuclei are outlined, together with some of the problems of producing and studying nuclei far off the stability line. (D.C.W.)

30113 PRODUCTION RATES OF NUCLIDES FAR OFF THE STABILITY LINE. Rudstam, Goesta (Swedish Research Councils' Lab., Nykoeping, Sweden). Ark. Fys., 36: 9-17(1967).

From International Symposium on Why and How Should We Investigate Nuclides Far Off the Stability Line, Lysekil, Sweden. See CONF-660817.

A comparison of methods for producing neutron-deficient and neutron-rich unstable nuclei is presented. The methods considered include charged particle- and neutron-induced reactions, spallation, heavy ion-induced reactions, and fission. (D.C.W.)

30114 PRODUCTION OF NUCLIDES FAR OFF THE STABILITY LINE BY PHOTONUCLEAR REACTIONS. Forkman, Bengt; Jonsson, Goeran G. (Univ. of Lund, Sweden). Ark. Fys., 36: 57-60(1967).

From International Symposium on Why and How Should We Investigate Nuclides Far Off the Stability Line, Lysekil, Sweden. See CONF-660817.

The use of bremsstrahlung in reactions of the type (γ,xn) is briefly investigated for the production of nuclei which are far from the stability line. To illustrate the type of information that is obtained from high energy photo-absorption experiments, some data are presented for iodine exposed to bremsstrahlung at different maximum energies. (S.F.L.)

30115 DESIGN STUDY FOR A CIRCULATING-LIQUID TARGET. Chackett, K. F. (Rutherford Lab., Chilton, Eng.). Ark. Fys., 36: 133-50(1967).

From International Symposium on Why and How Should We Investigate Nuclides Far Off the Stability Line, Lysekil, Sweden. See CONF-660817.

In order to produce short-lived isotopes (~1 second) and to study them in an on-line mass separator a design study was undertaken on a circulating liquid metal target for a proton synchrotron. Some of the aspects of this design study are presented. These include principles of operation, materials of construction, pump design, choice of target material, design of target and jet chambers, and instrumentation and control. An appendix includes the diffusion the diffusion of activity in a spherical drop. (B.G.D.)

30116 ON- AND OFF-LINE EXPERIMENTS WITH MEGAGAUSS INTERNAL MAGNETIC FIELDS. Deutch, B. I.; Hornshoej, P.; Nielsen, K. Bonde (Univ. of Aarhus, Denmark). Ark. Fys., 36: 157-62(1967).

From International Symposium on Why and How Should We Investigate Nuclides Far Off the Stability Line, Lysekil, Sweden. See CONF-660817.

The nuclei of isotope-séparated impurities embedded in ferromagnetic foil that is magnetized by means of a small magnet have been shown to interact with megagauss internal magnetic fields. Using gamma-gamma correlation techniques with this magnet, the Larmor precession angle $\Delta\theta$ can be determined in on- or off-line experiments where $\Delta\theta = -2.74 \cdot 10^5\, gB\tau$ degrees, and g is the g factor for the excited level, B the effective magnetic field, and τ the mean-life of the level. The B may be determined separately for a given element, yielding the product function $g\tau$. As an example, the application of this method is discussed for the iodine daughters of the easily separable xenon isotopes. Xenon isotopes of half-life 10 s or longer which decay through intermediate states in the range $10^{-9} \geq \tau \geq 7 \times 10^{-12}$ s may be measurable via this technique. (auth)

30117 DECAY OF HIGH ANGULAR MOMENTUM STATES POPULATED IN HEAVY-ION REACTIONS. Jaegare, S. (NORDITA, Copenhagen). Ark. Fys., 36: 237-40(1967).

From International Symposium on Why and How Should We Investigate Nuclides Far Off the Stability Line, Lysekil, Sweden. See CONF-660817.

Spin distributions in compound nuclear reactions initiated by heavy ions on nuclei in the rare earth region were calculated using the statistical model. The results show that the highest angular momentum states populated decay predominantly by the emission of alpha particles. (auth)

REACTOR TECHNOLOGY

Central Power Reactors

Refer also to abstracts 27740, 27954, 27974, 27999, 28037, 28072, 28084, 28209, 28215, 28216, 28229, 28244, 28246, 28729, 28885, 28970, 30292, 30294, 30296, and 30298.

30118 (ANL-7438) REACTOR DEVELOPMENT PROGRAM. Progress Report, March 1968. (Argonne National Lab., Ill.). Apr. 26, 1968. Contract W-31-109-eng-38. 135p. Dep. CFSTI.

EXPERIMENTAL BOILING WATER REACTOR—pressure vessel for, postirradiation examination of
REACTORS, LIQUID METAL-COOLED—fuel elements for, fuel-cladding interaction in metallic; coolant channels in, heat transfer calculations for
REACTOR FUEL ELEMENTS—cladding for LMFBR, metallic interaction of fuel material with; radiation effects on LMFBR oxide; cladding for LMFBR carbide compatibility of materials for fuels and; jacket alloys for, radiation effects on; swelling of, effects of pressure on radioinduced; radiation effects on EBR-II encapsulated Mark-II; gripper and holddown force-limit device for, calibration of; cladding for, mechanical properties of Type 304 L stainless steel; rare earth fission products in spent, use of x-ray spectrometer for determination of; radiation effects on advanced ceramic; temperature changes in plutonium oxide, molar enthalpy changes for
VANADIUM ALLOYS AND SYSTEMS—Cr-Ti-V-base, compatibility of cladding of, with LMFBR carbide fuels
CHROMIUM ALLOYS AND SYSTEMS—Cr-Ti-V-base, compatibility of cladding of, with LMFBR carbide fuels
TITANIUM ALLOYS AND SYSTEMS—Cr-Ti-V-base, compatibility of cladding of, with LMFBR carbide fuels
URANIUM CARBIDES—fuel pellets of, pressing and sintering of
CRITICAL ASSEMBLIES—reactivity worth measurements in the FTR Phase B mockup in ZPR-3, sodium; reactivity measurements in ZPR-3, effects of fuel compaction on; reactivity worth measurements in 4000-liter oxide core in ZPR-6; Doppler coefficient measurements in uranium oxide zoned core of ZPR-9 fast; development and construction of ZPPR, status as of March 1968 of; reactivity coefficients for, effects of geometry on
TANTALUM—reactivity worth of, measurement in ZPR-3 of,
BORON CARBIDES—reactivity worth of, measurement in ZPR-3 of
URANIUM—reactivity worth of, measurement in ZPR-3 of
REACTIVITY—Doppler coefficient of, measurement in uranium oxide zoned core of ZPR-9
PLUTONIUM ISOTOPES Pu-239—alpha cross section for, effects on ZPR-3 reactivity of
STRAIN GAGES—sensitivity and zero shift measurements on LMFBR, effects of temperature on
XENON—activity in EBR-II cover gas, measurement of
EXPERIMENTAL BREEDER REACTOR-II—power-reactivity decrement in, effects of reduced coolant flow on; cover gas for, xenon activity in; sodium coolant for, determination of iodine-131 and iodine-133 in primary; operations history for, Feb. 23 to Mar. 12, 1968; fueled control rods with boron carbide followers for, calculated reactivity for movement of; control rods for, calculated reactivity for movement of fully poisoned; sodium coolant for, impurity and activity determination for; experiment irradiations in, tabular summary of; instrument thimble in, gamma flux map of 01; fuel elements for, mechanical properties of Type 304 L stainless steel for cladding of; fuel cycle facility for, production summaries for
SODIUM—coolant for EBR-II, determination of iodine-131 and iodine-133 in primary
URANIUM ALLOYS AND SYSTEMS—fissium-U, fuels of, radiation effects on
FISSIUM—Fissium-U fuels of, radiation effects on
REMOTE HANDLING EQUIPMENT—calibration of fuel element gripper and holddown force-limit; performance testing under operations conditions of manipulators
SODIUM—impurities in EBR-II primary, determination of trace-metal; impurities in liquid, use of hexahydroxy benzene and EDTA for recovery of carbon; high-temperature boiling experiments on
CARBON—recovery from liquid sodium, use of hexahydroxy benzene and EDTA for
FISSION PRODUCTS—determination in spent fuel of rare earth, use of x-ray spectrometer for
RARE EARTHS—determination in spent fuels, use of x-ray spectrometer for
URANIUM ISOTOPES U-235—fission of, mass-angle-energy determinations for neutron-induced
NEUTRONS—fissioning of uranium-235 by, mass-angle-energy determinations from
PLUTONIUM OXIDES PuO_2—fuel elements of, molar enthalpy changes for various temperature drops in; thermodynamic properties of
MATERIALS TESTING, NONDESTRUCTIVE—neutron radiography for, development of activation-transfer method for
HEAT EXCHANGERS—efficiency of liquid metal nonsymmetrical-duct
FLUID FLOW—Diffusivity of turbulent particles, calculation of
PLUTONIUM—reactivity worth of, measurement in ZPR-3 of; separation from ruthenium, use of transpiration technique for; removal from plutonium hexafluorides, effects of presence of fluorine gas on
ARGONNE ADVANCED RESEARCH REACTOR—reflector for, heat transfer calculations for; beam tubes for, effects of pressure on seals for; rabbit systems for, temperature profiles, for the internal thermal column
RUTHENIUM—separation from plutonium, use of transpiration technique for
NEPTUNIUM FLUORIDES NpF—separation from uranium fluorides, fluid-bed volatility process for
URANIUM FLUORIDES UF_6—separation from neptunium fluorides, fluid-bed volatility process for
CALCIUM OXIDES—solubility in calcium halides, effects of temperature on
CADMIUM ALLOYS AND SYSTEMS—Cd-Mg, mass transfer coefficients for cerium in
MAGNESIUM ALLOYS AND SYSTEMS—Cd-Mg, mass transfer coefficients for cerium in
REACTOR EXPERIMENTAL FACILITIES—temperature profiles in AARR hydraulic and gas-cooled rabbits
REACTOR SAFETY EXPERIMENTS—core for TREAT, design parameters for softer spectrum
URANIUM OXIDES UO_2—enthalpy measurements of liquid, use of tungsten powder for
TUNGSTEN—use of powdered, liquid uranium dioxide enthalpy measurements through
REACTORS, WATER-COOLED—coolant loss accident simulation for, use of zircaloy-Z clad uranium dioxide pellets for out-of-pile; heat transfer measurements for, use of heated metal spheres for forced-convection
PLUTONIUM FLUORIDES PuF_6—purification of, evaluation of fluid-bed fluoride volatility process for; plutonium removal from, effects of presence of fluorine gas on
REACTORS, POWER—coolant loss accident simulation for, use of zircaloy-Z clad uranium dioxide pellets for out-of-pile; heat transfer measurements for, use of heated metal spheres for forced-convection (M.L.S.)

30119 (APDA-CFE-18) COMPILATION OF CURRENT TECHNICAL EXPERIENCE AT ENRICO FERMI ATOMIC POWER PLANT, JANUARY 1968. (Atomic Power Development Associates, Inc., Detroit, Mich. Power Reactor Development Co., Detroit, Mich. Detroit Edison Co., Mich.). Contract AT(11-1)-865. 48p. Dep. CFSTI.

Description of the identified object in the core inlet plenum is presented. Photographs of the Zr segment mockup and actual core condition are presented. Removal plans for the object are described. Tools designed for use in the removal operation are described. Sodium levels in the cooling system piping are presented. The description of the PRDC borescope is presented. Radiation levels in various reactor segments are listed. (D.C.C.)

30120 (APDA-NTS-17) NUCLEAR POWER CALIBRATION AND LINEARITY INVESTIGATION OF THE NEUTRON DETECTORS IN THE ENRICO FERMI REACTOR. Callen, R. C.; Page, E. M. (Atomic Power Development Associates, Inc., Detroit, Mich.). Mar. 1968. 44p.

The power calibration of the Enrico Fermi reactor was obtained at low powers (~100 W) by nuclear techniques, using an absolute fission counter in the reactor core. Neutron flux detectors for temporary start-up were calibrated from which permanent plant detectors were later calibrated when they were installed. Disturbances to the detectors were the major cause of increasing the probable error of the calibration from an optimum 4% to the resultant 9%. Extraneous sources of disturbance to the reactor neutron leakage rate with power were investigated. Experiments

were performed to investigate nonlinear relations of leakage detector response and power level up to 100 Mw; none were found. (auth)

30121 (BMI-X-10229) FISSION-PRODUCT DEPOSITION AND ITS ENHANCEMENT UNDER REACTOR ACCIDENT CONDITIONS. Quarterly Progress Report, January–March 1968. Genco, Joseph M.; Rosenberg, Harvey S.; Berry, David A.; Berry, Warren E.; Cremeans, George E.; Ritzman, Robert L.; Drauglis, Edmund J.; Morrison, David L. (Battelle Memorial Inst., Columbus, Ohio). Apr. 1, 1968. Contract W-7405-eng-92. 62p. (EURAEC-2021). Dep. CFSTI.

Work performed under United States–Euratom Joint Research and Development Program.

IODINE — depositions on tubes, end effects and anomalous behavior of; deposition on painted surfaces of elemental, vapor-phase; mass transfer coefficients for, gas-phase; deposition on containment vessels, effects of compartmenting on; deposition on asbestos mat, mass transfer coefficients for; deposition on coatings, gamma radiation effects on rate of

HYDRIODIC ACID — deposition on prefilmed Type 304 stainless steel, mass transfer rate of vaporous; deposition on containment system coatings

STAINLESS STEELS — hydrogen iodide deposition on Type 304, mass transfer rate of vaporous; autoradiographs of pre-oxidized

ZIRCALOY-4 — hydrogen iodide deposition on, mass transfer rate of vaporous

REACTOR CONTAINMENT SYSTEMS — coatings for, liquid-phase hydrogen iodide deposition on; coatings for, liquid-phase deposition of cesium ions from aqueous cesium chloride on

COATINGS — hydrogen iodide deposition on containment systems, mass transfer rate of liquid-phase; cesium ion deposition on containment system, liquid-phase; deposition of iodine and methyl iodide on paint-type; iodine deposition on containment, gas-phase mass-transfer effects on; iodine deposition rate on, gamma radiation effects on; methyl iodide deposition rate on, gamma radiation effects on; performance in power reactor containment systems, criteria for

CESIUM IONS — deposition on containment system coatings from aqueous cesium chloride solutions

METHANE, IODO- — deposition on painted surfaces

REACTOR CONTAINMENT STRUCTURES — compartmenting of, effects on gaseous fission product deposition of

ASBESTOS — iodine deposition on, mass transfer coefficient for; methyl iodide deposition on, mass transfer coefficient for

METHANE, IODO- — deposition on asbestos mat, mass transfer coefficients for; deposition on coatings, gamma radiation effects on rate of

REACTORS, PRESSURIZED-WATER — design basis accidents in, containment conditions for

REACTORS, BOILING — design basis accidents in, containment conditions for

REACTORS, POWER — containment systems coatings for, criteria for performance of (M.L.S.)

30122 (BNWL-653) DETERMINATION OF RELATIVE BURNUP BY GAMMA SCANNING EBWR FUEL RODS. Christensen, D. E.; Murphy, E. S. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Apr. 1968. Contract AT(45-1)-1830. 37p. Dep. CFSTI.

A set of 17 fuel rods from the Experimental Boiling Water Reactor were gamma scanned using both a NaI detector and a Ge detector. The intensity of the unresolved fuel rod gamma ray spectrum above 675 keV was measured at several points along each rod in order to determine the relative fuel burnup and core power distribution. (H.D.R.)

30123 (BNWL-SA-1550) CERAMIC FUELS FOR FAST REACTORS. Goldsmith, Stanley; Jackson, R. J.; Weber, E. T. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Mar. 28, 1968. Contract AT(45-1)-1830. 25p. (CONF-680419-3). Dep. CFSTI.

From American Nuclear Society National Topical Meeting, Cincinnati, Ohio.

The performance potential of the U–Pu ceramic compounds — oxides, carbides, and nitrides — under current development as liquid-metal-cooled fast breeder reactor fuels is discussed. The fast reactor fuel operating conditions and material characteristics are examined, and thermal properties, swelling behavior, and compatibility of the fuels with cladding and with Na are compared. Factors which influence fuel pin performance are examined, and the need for information on prototype fuel pin operation under conditions representative of fast reactors is discussed. (H.D.R.)

30124 (CVNA-295) CVTR LEAKAGE RATE INSTRUMENTATION EVALUATION. Barrow, W. E. (Carolinas Virginia Nuclear Power Associates, Inc., Columbia, S. C.). Nov. 1967. 56p. Dep. CFSTI.

A test was made to determine the accuracy and sensitivity of the CVTR continuous leakage rate system so as to evaluate the usefulness of such systems in power reactor containment testing. A continuous leak rate test was performed at 2 psig for 22 days, only 10 of which produced reliable data. The method used, test equipment, results, and interpretation of the test data are presented. (H.D.R.)

30125 (DOCKET-50219-1) OYSTER CREEK NUCLEAR POWER PLANT, UNIT NO. 1. Facility Description and Safety Analysis Report [Final], Amendment 3, Pt. 1, Vol. 1. (Jersey Central Power and Light Co., Morristown, N. J.). Jan. 25, 1967. 355p. Dep. CFSTI.

Information on Oyster Creek Power Reactor, Unit 1 is given under the following broad topics: Introduction and Summary; Site and Environs; Reactor; Reactor Coolant System; Containment Systems; Additional Engineered Safeguards; Control and Instrumentation; Electrical Systems; Radioactive Waste Control; Reactor Auxiliary Service and Systems; Turbine Generator and Condensate; Conduct of Operations; and Safety Analyses. (M.L.S.)

30126 (DOCKET-50219-2) OYSTER CREEK NUCLEAR POWER PLANT, UNIT NO. 1. Facility Description and Safety Analysis Report [Final], Amendment 3, Pt. 2, Vol. 2. (Jersey Central Power and Light Co., Morristown, N. J.). Jan. 25, 1967. 315p. Dep. CFSTI.

All engineering design drawings for the Oyster Creek Power Reactor, Unit 1 are presented. Appendices include: Summary of Operating Experience with In-Core Chamber Neutron Monitoring Systems; Control Rod Drive System Description and Analysis; Comparison of Theoretical Containment Pressure Calculations with Test Data, Reactor Core Spray Cooling System Test Program, Heat Transfer During Blowdown, Containment Fission Product Retention Capability, Strain Safety Margin for Reactor Pressure Vessels, Core Heatup Analysis Model, and Reactor Coolant Inventory Model. (M.L.S.)

30127 (DOCKET-50219-3) OYSTER CREEK NUCLEAR POWER PLANT, UNIT NO. 1. [Facility Description and Safety Analysis Report], Amendment 5. (Jersey Central Power and Light Co., Morristown, N. J.). June 5, 1967. 128p. Dep. CFSTI.

Various aspects of the Oyster Creek Power Reactor, Unit 1 core spray system are discussed; these include spray distribution factor, effects of nozzle damage or nozzle removal on spray distribution, containment and pressure vessel depressurization effects, spray pump characteristics, and form factor determination. Use of the single mode model for calculation of the effective depressurization of the feedwater system is discussed. Effects of input variables on core thermal response following a loss-of-coolant accident are detailed; results are shown graphically. The effects of delayed actuation of the auto-relief system of the emergency core cooling network are analyzed. Fuel-element cladding-to-coolant heat transfer coefficients are given; fuel element temperatures and possible fuel damage under loss-of-coolant conditions are shown graphically as a function of time after accident. Core internal pressure differentials are given as a function of cooling system piping break size. A complete blowdown analysis showing a net reactivity decrease during a loss-of-coolant accident is given. (M.L.S.)

30128 (DOCKET-50219-4) OYSTER CREEK NUCLEAR POWER PLANT, UNIT NO. 1. [Facility Description and Safety Analysis Report], Amendment 1. (Jersey Central Power and Light Co., Morristown, N. J.). May 12, 1964. 57p. Dep. CFSTI.

The 1963 Annual Report of the Jersey Central Power and Light Company, owner of Oyster Creek Power Reactor, Unit 1, is given in support of an application for construction permit and operating license for the reactor. The 1963 financial statement of the General Public Utilities, of which Jersey Central is a subsidiary is included, also. (M.L.S.)

30129 (DOCKET-50219-5) OYSTER CREEK NUCLEAR POWER PLANT, UNIT NO. 1. [Facility Description and Safety Analysis Report], Amendment 2. (Jersey Central Power and Light Co., Morristown, N. J.). July 2, 1964. 132p. Dep. CFSTI.

Information on the reactor building and pressure vessel for Oyster Creek Power Reactor, Unit 1 is given; the in-service testing program is described. The emergency condenser system, poison systems, and nuclear instrumentation systems are discussed. The emergency power supply system is detailed. Dynamic characteristics of the Oyster Creek Power Reactor are considered briefly. The population distribution for the Oyster Creek site is tabulated. Frequency and severity of storms in the locale is documented. The consequences of an accidental radio-

activity release to Barnegat Bay are evaluated. The assumed maximum credible accident is described; radiological effects are detailed; the calculational model is discussed. Transient pressures and shock waves resulting from credible accidents are described. The function of the main steam line isolation valves is discussed. The hypothetical accident of control rod thimble break and consequent control rod ejection is analyzed; mathematical models and formulas used for analysis are given; data are tabulated. The zirconium-water reaction contribution to pressure transients is evaluated. A detailed analysis is given of a nuclear excursion violent enough to release fission products from the fuel. The assumed accident is caused by a $2.10 step reactivity insertion. Effects of the excursion, both internal and external to the reactor, are shown graphically. (M.L.S.)

30130 (DOCKET-50219-6) OYSTER CREEK NUCLEAR POWER PLANT, UNIT NO. 1. Facility Description and Safety Analysis Report, Amendment 4. (Jersey Central Power and Light Co., Morristown, N. J.). Feb. 28, 1967. 32p. Dep. CFSTI.

The availability of standby cooling systems for the Oyster Creek Power Reactor, Unit 1 is described in detail. Each system is described separately; these include: core spray, automatic depressurization, containment spray, and off-site power availability during loss-of-coolant accidents. The availability calculation method is detailed. (M.L.S.)

30131 (DOCKET-50219-7) OYSTER CREEK NUCLEAR POWER PLANT, [UNIT NO. 1]. Facility Description and Safety Analysis Report, Amendment 14. (Jersey Central Power and Light Co., Morristown, N. J.). Oct. 31, 1967. 56p. Dep. CFSTI.

Changed or revised pages to the Oyster Creek Power Reactor, Unit 1 Facility Description and Safety Analysis Report are included. (M.L.S.)

30132 (DOCKET-50219-8) OYSTER CREEK NUCLEAR POWER PLANT, UNIT NO. 1. [Facility Description and Safety Analysis Report], Amendment 19. (Jersey Central Power and Light Co., Morristown, N. J.). Oct. 19, 1967. 9p. Dep. CFSTI.

The effects of small breaks in the reactor vessel of the Oyster Creek Power Reactor, Unit 1 are discussed. The function of the auto-relief system, which is part of the emergency core cooling network, is described briefly. (M.L.S.)

30133 (DOCKET-50219-9) OYSTER CREEK NUCLEAR POWER PLANT, [UNIT NO. 1]. [Facility Description and Safety Analysis Report], Amendment 20. (Jersey Central Power and Light Co., Morristown, N. J.). Oct. 19, 1967. 26p. Dep. CFSTI.

Power level scram trip set points for Oyster Creek Power Reactor, Unit 1 are evaluated. Effects of reactor vessel blowdown transients on the drywell liner are discussed. Coolant flow rates under blowdown conditions are tabulated. Specifications for the source range monitor system, intermediate range monitor system, power range monitor system, and area radiation monitor are given. (M.L.S.)

30134 (DOCKET-50219-10) OYSTER CREEK NUCLEAR POWER PLANT, [UNIT NO. 1]. [Facility Description and Safety Analysis Report], Amendment 21. (Jersey Central Power and Light Co., Morristown, N. J.). Oct. 19, 1967. 21p. Dep. CFSTI.

Various phases of the emergency planning for Oyster Creek Power Reactor, Unit 1 are discussed; these include determination of off-site dose levels following an accident, coordination of assistance from state and local emergency groups, and post-accident recovery. Qualifications and membership of the Review Board are given. (M.L.S.)

30135 (DOCKET-50219-11) OYSTER CREEK NUCLEAR POWER PLANT, UNIT NO. 1. [Facility Description and Safety Analysis Report], Amendment 22. (Jersey Central Power and Light Co., Morristown, N. J.). Oct. 27, 1967. 35p. Dep. CFSTI.

Allowable stresses for containment and reactor building components for the Oyster Creek Power Reactor, Unit 1 are tabulated. Evaluations of earthquake-induced motion or failure of reactor building, turbine building, and stack are described. Effects of hurricane-induced flooding of the Oyster Creek site are evaluated. An evaluation of the Oyster Creek plant with respect to ACRS findings on Browns Ferry and Vermont Yankee is detailed. (M.L.S.)

30136 (DOCKET-50219-12) OYSTER CREEK NUCLEAR POWER PLANT, UNIT NO. 1. [Facility Description and Safety Analysis Report], Amendment 24. (Jersey Central Power and Light Co., Morristown, N. J.). Oct. 31, 1967. 16p. Dep. CFSTI.

Isolation of the main steam line for the Oyster Creek Power Reactor, Unit 1 is discussed. Control circuits and operational modes for the valves are described; in-service testing procedures are detailed. (M.L.S.)

30137 (DOCKET-50219-13) OYSTER CREEK NUCLEAR POWER PLANT, UNIT NO. 1. [Facility Description and Safety Analysis Report], Amendment 25. (Jersey Central Power and Light Co., Morristown, N. J.). Nov. 27, 1967. 31p. Dep. CFSTI.

A complete description of the proposed high pressure coolant injection system for the Oyster Creek Power Reactor, Unit 1 is given. Modifications of the existing mechanical and electrical systems are outlined; operational sequences are detailed. Performance of the proposed system is evaluated from a point of protection. Design drawings are included. (M.L.S.)

30138 (DOCKET-50245-4) [MILLSTONE NUCLEAR POWER STATION, UNIT 1]. APPENDIX B. PRE-OPERATION AND STARTUP TESTS. [Final Safety Analysis Report], Amendment 6. (Connecticut Light and Power Co., Hartford, Hartford Electric Co., Conn. Western Massachusetts Electric Co., Greenfield, Millstone Point Co., Wethersfield, Conn.). May 6, 1968. 27p. Dep. CFSTI.

Complete procedures for startup tests for Millstone Point Power Reactor are given. Summary descriptions of all 46 tests are tabulated. (M.L.S.)

30139 (DOCKET-50272-8) SALEM NUCLEAR GENERATING STATION. [Preliminary Facility Description and Safety Analysis Report], Amendment 8. (Public Service Electric and Gas Co., Newark, N. J.). May 6, 1968. 126p. (DOCKET-50311-8). Dep. CFSTI.

Effects of design water levels on the Salem Power Reactor are considered; soil foundation data are analyzed; effects of soil type are detailed. Relative soil densities are shown graphically. The Dawes and Moore report on site soil liquefaction studies is included. Seismic design of the containment structure is discussed; effects of earthquake loading are considered. Effects of tornado loadings on containment structures are evaluated. The testing and in-service surveillance program for the containment system is described. (M.L.S.)

30140 (DOCKET-50321-1) EDWIN I. HATCH NUCLEAR PLANT, [UNIT 1]. Preliminary Safety Analysis Report, Vol. 1. (Georgia Power Co., Atlanta). May 1968. 309p. Dep. CFSTI.

Information on the Edwin I. Hatch Power Reactor, Unit 1 is given under the following broad topics: Introduction and Summary; Site and Environment; Reactor Core; Reactor Coolant System; Containment Systems; and Engineered Safeguards including emergency core cooling systems (ECCS), reactor core-spray cooling system (RCSCS), reactor core-residual heat removal system (RHRS), reactor core-high pressure coolant injection system (HPCIS), plant standby coolant supply system, integrated ECCS and containment cooling systems performance evaluation, reactor core-RHRS-low pressure coolant injection system (LPCIS) logic control instrumentation, main steam line flow restrictions, control rod velocity limiters, control rod drive housing supports, reactor standby liquid control system, and primary containment atmospheric control system. (M.L.S.)

30141 (DOCKET-50321-2) EDWIN I. HATCH NUCLEAR PLANT, [UNIT 1]. Preliminary Safety Analysis Report, Vol. 2. (Georgia Power Co., Atlanta). May 1968. 351p. Dep. CFSTI.

Information on Edwin I. Hatch Power Reactor, Unit I is given under the following broad topics: Instrumentation and Control Systems including reactor control systems, nuclear instrumentation systems, reactor vessel instrumentation system, radiation monitoring systems, plant protection systems, turbine-generator systems instrumentation and control, process on-line computer and control rod worth monitor system, and process systems instrumentation and control; Electrical Power Systems; Radioactive Waste Control Systems; Auxiliary and Emergency Systems; Steam and Power Conversion Systems; Structures and Shielding including principal plant structures and foundations, bases and design evaluation, design criteria, construction materials, and plant shielding design; Plant Operations; and Safety and Accident Analysis including control features, inherent reactor safety features, engineered safeguards, containment features, incidents and accidents, incident analyses, design basis accident analyses, and analytical methods. (M.L.S.)

30142 (DOCKET-50321-3) EDWIN I. HATCH NUCLEAR PLANT, [UNIT 1]. Preliminary Safety Analysis Report, Vol. 3. (Georgia Power Co., Atlanta). May 1968. 228p. Dep. CFSTI.

Information on Edwin I. Hatch Power Reactor, Unit I is contained under the following topics: Hydrology; Geology and Seismology; and

Foundations including field exploration, site conditions, soil conditions, laboratory testing, structural data, and foundation evaluation. (M.L.S.)

30143 (DOCKET-50321-4) EDWIN I. HATCH NUCLEAR PLANT, [UNIT 1]. Preliminary Safety Analysis Report, Vol. 4. (Georgia Power Co., Atlanta). May 1968. 183p. Dep. CFSTI.

Information on the Edwin I. Hatch Power Reactor, Unit I is detailed on the following subjects: Reactor Core Thermal Design; Control Rod Drive System—Description and Analysis; Jet Pump Development Program; Reactor Core Spray Cooling Test Program; Outline of Proposed Technical Specifications; and Comparative Evaluation with AEC Design Criteria. (M.L.S.)

30144 (EUR-3892) INTERET ECONOMIQUE D'UNE ELEVATION DES CARACTERISTIQUES DU CIRCUIT PRIMAIRE D'UNE CENTRALE TYPE GRAPHITE-GAZ. Rapport Final. (Economic Usefulness of Raising the Primary Circuit Characteristics of a Graphite-Gas Power Plant. Final Report). (Societe Alsthom, Paris (France)). June 14, 1967. 126p. (In French). Dep.

In the latter years the characteristic trend in graphite-gas nuclear power plants has been the shift of the cooling circuit from the outside to the inside of the reactor pressure vessel. This development became possible through the adoption of the prestressed concrete vessel. The greater safety afforded by the integrated design permits higher operating temperatures and pressure than those in non-integrated reactors. With the heat exchangers inside the pressure vessel, however, the question arises as to whether it is preferable to choose a steam cycle that requires fewer runs through the vessel at the expense of efficiency, or whether efficiency should be the principal aim. These two aspects of integration, enhanced characteristics on the one hand and choice of steam cycle on the other, are obviously related and it is worth assessing their economic consequences insofar as this concerns the primary and secondary systems, so that users can weigh them together with the price changes for the rest of the power plant and the additional stresses imposed on the fuel. The purpose of the present study contract is to carry out a general efficiency study and also to determine, in various specific cases, how the prices for the primary and secondary circuit mechanical sub-assemblies would vary from a reference solution, so as to show by difference what additional investments would be admissible for the reactor itself. The various cases studied will relate to a power plant with one integrated graphite-gas reactor with a net capacity of 500 MW(e), comprising four blower sets and a turboalternator set. The study will consist of two parts: General Studies, dealing with the influence on power plant efficiency of the different parameters characterizing the reactor and steam cycle. Special Studies, to deal in detail with the findings of the General Studies regarding efficiency values, and also to examine the constructional and economic angles. By comparing the six cases studied, the difficulties in each solution can be identified and weighed against the differences between the various efficiencies. (auth)

30145 (EUR-3900) KOHLENSTOFFTRANSPORT IN DEN HOCHTEMPERATURREAKTOREN THTR UND AVR. (Carbon Transport in the THTR and AVR High-Temperature Reactors). Stolz, E.; Werner, L. (Brown Boveri/Krupp Reaktorbau G.m.b.H., Mannheim (West Germany)). Mar. 1968. Contract 003-63-1 RGAD. 26p. (In German). (THTR-44). Dep.

Since the beginning of the HTGR development project, the points of view concerning the design of the gas clean-up unit have undergone a shift of emphasis, moving from the active to the inactive impurities. The design criteria are essentially based on the carbon transport, i.e., corrosion of the fuel elements and carbon deposition on the steam generators. The impurities in the cooling gas are H_2, CO, H_2O, and CO_2, the H_2O leakage from the steam generators. The reactions and the kinetics of graphite corrosion and carbon deposition are explained and, taking the AVR and THTR projects as examples, the effects discussed. Corrosion of the fuel elements limits the permissible leakage rate from the steam generators; in order to avoid carbon deposition, a certain minimum flow is necessary in the gas clean-up unit. 17 references. (auth)

30146 (EURAEC-1983) FINAL TECHNICAL REPORT ON DATA COMPUTING SYSTEM INSTALLED AT GARIGLIANO NUCLEAR POWER PLANT. Special Report No. 6. Cammarota, Umberto; Gangemi, Franco; Jovine, Riccardo; Santasilia, Franco (Ente Nazionale per l'Energia Elettrica, Rome (Italy)). Nov. 1967. Contract 101-63-11-RDI. 20p. (EUR-3781). Dep. CFSTI.

Work Performed under United States-Euratom Joint Research and Development Program.

A summary of information on the installation and operations testing of the on-line computer system for the Garigliano Power Reactor is presented. Problems in checkout and functioning are outlined. The computer codes used for the reactor monitoring are described. (M.L.S.)

30147 (EURAEC-1984) THERMOHYDRAULIC INSTABILITY OF BOILING-WATER REACTORS, CONSIDERATIONS ON RESULTS OF OSCILLATION TRIALS IN GARIGLIANO POWER PLANT. Special Report No. 7. (Ente Nazionale per l'Energia Elettrica, Rome (Italy)). Nov. 1967. Contract 101-63-11-RDI. 116p. (EUR-3782). Dep. CFSTI.

Work Performed under United States-Euratom Joint Research and Development Program.

Theoretical and experimental aspects of the problem of thermohydraulic stability of a boiling channel are discussed. Basic features of some theoretical models used by General Electric for studing thermohydraulic stability in boiling water reactors are described. Processing procedures and analysis of results of Garigliano rod oscillation tests are presented. (H.D.R.)

30148 (GA-8040) ENGINEERING TESTS DURING THE INITIAL OPERATION OF THE PEACH BOTTOM HTGR. Kantor, M. E.; Menzel, H. F.; Schlicht, R. W.; Westlake, W. J. Jr. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). June 16, 1967. Contract AT(04-3)-314. 29p. (CONF-670602-29). Dep. CFSTI.

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif.

The description of engineering evaluation tests to establish a power escalation program is presented. The tests are designed to demonstrate the operational behavior of the major components and subsystems of the nuclear steam supply system and to verify that the overall plant performance is within the predicted limits. The components and subsystems tested are: the two steam generators; the two helium compressors; the overall plant control and safety system; the helium purification and fission product trapping system; and the steam turbine-generator and feedwater supply system. Tests results are presented. (D.C.C.)

30149 (GA-8623) FORT ST. VRAIN PRESTRESSED CONCRETE REACTOR VESSEL. Walker, R. F. (Public Service Co. of Colorado, Denver); Northup, T. E. (Gulf General Atomic, Inc., San Diego, Calif.). 1968. Contract AT(04-3)-633. 19p. (CONF-680418-1). Dep. CFSTI.

From 30th Annual American Power Conference, Chicago, Ill.

A brief description of the Fort St. Vrain reactor system and operating parameters is presented. Engineering and construction aspects of the prestressed concrete reactor pressure vessel are also presented. Testing methods for the prestressed concrete pressure vessel are described. (D.C.C.)

30150 (GEAP-5597) RADIAL VANE STEAM SEPARATOR DEVELOPMENT. Tenth Quarterly Report, Phase II, October-December 1967. Moen, R. H.; Gifford, J. E. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Jan. 1968. Contract AT(04-3)-189. 27p. (EURAEC-2019). Dep. CFSTI.

Work performed under United States-Euratom Joint Research and Development Program.

A description of the radial vane steam separator and the principle of operation are given, and some of the test equipment and facilities are described. Data are presented for air-water tests of the model full-circle radial vane separator designated FCRV-4. These tests were performed to determine the effect of plenum deflector design on performance. A report of a trip to West Germany and Belgium to discuss the development program is also included. (H.D.R.)

30151 (KAPL-M-6742) STUDY OF THE MULTICHANNEL SYNTHESIS METHOD FOR SPACE-TIME NEUTRONICS. Stacey, Weston M. Jr. (Knolls Atomic Power Lab., Schenectady, N. Y.). Nov. 1967. Contract W-31-109-Eng-52. 69p. Dep. CFSTI.

A multichannel space-time synthesis model for the calculation of nonseparable reactor transients is developed from a variational principle which admits expansion functions that are discontinuous in space and time. In each of many spatial regions, the flux during each interval of time is expanded in known functions of position with unknown expansion coefficients. The accuracy of the method, and its superiority with respect to the conventional single-channel space-time synthesis method, are demonstrated by several numerical examples. (auth)

30152 (KAPL-P-3180) INFLUENCE OF COOLANT PASS ARRANGEMENT ON NUCLEAR PLANT DYNAMICS. Becker, M.; Hogue, D. C.; Rubin, H. H. (Knolls Atomic Power Lab., Schenectady, N. Y.). [nd]. Contract W-31-109-eng-52. 30p. (CONF-661001-55). Dep. CFSTI.

From 14th Conference on Remote Systems and Technology, Pittsburgh, Pa.

The dynamics and stability characteristics of nuclear plant heterogeneous systems with single pass and two two-pass coolant

flow arrangements are examined. The analysis is confined to point reactor kinetics with emphasis on systems with temperature coefficients of different signs. Examined in separate sections are: open-loop stability criteria, closed-loop stability characteristics, transient analysis comparisons in different pass arrangements, power coefficient for constant average temperature control computed as functions of temperature coefficients and power fractions, and analysis of the influence on dynamic behavior of the variation of specific heat of coolant with temperature. (H.D.R.)

30153 (KFK-649) RECENT DEVELOPMENTS IN THE SEFOR EXPERIMENTAL PROGRAM. Noble, L.; Pflasterer, G. R.; Wilkinson, C. D.; Caldarola, L. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Reaktorphysik). Aug. 1967. 32p. (CONF-661019-12). Dep.

From International Conference on Fast Critical Experiments and Their Analysis, Argonne, Ill.

Three types of experiments are performed: static tests, oscillator tests, and transient (including super-prompt critical) tests. In the static tests, the power, flow, and inlet temperature are changed in such a way that the reactivity effect associated with a change in fuel temperature due to power only, the coolant temperature coefficient, the combined power and temperature coefficient, and the flow coefficient is determined. Three types of oscillator tests are analyzed. Transient tests are analyzed for various total reactivity worths and ejection rates at different power levels. Such tests allow the resctivity-energy coefficient to be determined over a wide range of fuel temperatures. A description of each test and of the power-temperature domain over which each test is performed based on current SEFOR design capabilities is presented. Analytical models for the various feedback effects, together with recently calculated coefficients consistent with the SEFOR mockup tests in ZPR-3 are given. Methods developed for the evaluation of the feedback coefficients in the analytical model from the results of the static, oscillator, and transient tests are described. The proposed instrumentation, data acquisition system and data processing techniques are also described. (auth)

30154 (KFK-675) WELCHE BEDEUTUNG HAT DER ELEKTRISCHE STROM IN DER DEUTSCHEN VOLKSWIRTSCHAFT? (What Significance has the Electric Current in the German Political Economy)? Faude, D. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Reaktorphysik). Oct. 1967. 37p. (In German). Dep.

Economic aspects of the use of nuclear energy for electricity production in the German Federal Republic are detailed; effects on the political economy are evaluated. Energy consumption by household is tabulated; industrial use is tabulated according to industry type. Energy costs are given in the tabulations. (M.L.S.)

30155 (NAA-SR-12296) AEC UNCLASSIFIED PROGRAMS. Quarterly Technical Progress Report, October–December 1966. (Atomics International, Canoga Park, Calif.). Oct. 25, 1967. Contract AT(04-3)-701. 151p. Dep. CFSTI.

NEUTRON CROSS SECTIONS—evaluation for fast reactor physics analysis, (E/T)
NEUTRONS—spectra in coolant and structural material of sodium-cooled reactors, (E); spectra distribution in fast reactors, analysis of energy and spatial, (T)
REACTORS, FAST—reactivity variations in, Doppler measurements on
REACTORS, LIQUID METAL COOLED—stability of sodium-cooled, effect of boiling and two-phase flow on, (E/T); cooling system of, behavior of fission products released in sodium, (E); coolant fires in, energy and fission product release in sodium, (E/T)
REACTOR SAFETY—coolant boiling and two-phase flow on sodium-cooled reactors, (E/T); fission product behavior in cooling system of sodium-cooled reactors, (E); coolant fires in sodium-cooled reactors, energy and fission product release in, (E/T)
REACTIVITY—Doppler coefficient of, method for determination of, (E/T)
HEATERS—development of long-length graphite high-flux, for fuel pin simulation
REACTOR FUELS—fission damage processes and mechanisms in, (E/T); preparation and properties of carbide-type, (E)
FISSION—effects on swelling of reactor fuel materials, (E/T)
SODIUM REACTOR EXPERIMENT—operation of, carbon removal and reliability testing during
REFRACTORY MATERIALS—properties for use as reactor moderators
GRAPHITE—crystal growth mechanisms and techniques for
SODIUM—analysis for impurities, procedures for; handling of pure, sampling and transfer procedures for; effects of liquid, on mechanical properties of fuel element cladding alloys, (E); solvent properties of liquid, for metals and nonmetals, (E)
REACTOR FUEL ELEMENTS—cladding material procurement procedures for; cladding materials for, mechanical properties measurements in liquid sodium on
STAINLESS STEEL—mechanical properties of type-316 and -321, in liquid sodium, (E); mechanical properties of irradiated type-304, effects of helium on, (E)
HEAT TRANSFER SYSTEMS—operation of dynamic sodium loop, for materials testing
HELIUM—effects of irradiation-produced, on mechanical properties of type-304 stainless steel, (E)
URANIUM CARBIDES—preparation and properties of, for use as reactor fuels, (E)
HALLAM POWER REACTOR—retirement activities during Oct. to Dec. 1966
FUSED SALTS—chemistry of, development of high temperature, (E/T)
SOLUTIONS—chemistry of metal-metal salt, development of high temperature, (E/T)
RADIATION CHEMISTRY—radiolysis processes in organic systems, (E)
ORGANIC COMPOUNDS—radiolysis of, fundamental physicochemical processes in, (E)
METALS—electronic structure effects on properties of, (E/T); radiation effects on physical properties of, (E/T)
ALLOYS—electronic structure effects on properties of, (E/T); radiation effects on physical properties of, (E/T)
SEMICONDUCTORS—radiation effects on physical properties of, (E/T)
RADIATION—effects on physical properties of alloys, metals, and semiconductors, (E/T)

30156 (ORNL-NSIC-43) COMPILATION OF UNITED STATES NUCLEAR STANDARDS. 4th Edition, 1967. (Oak Ridge National Lab., Tenn.). May 1968. Contract W-7405-eng-26. 147p. Dep. CFSTI.

A complete list of codes and standards which are applicable to the nuclear industry is given. The overall scope is international. The standards activities of all organizations, including technical societies and government agencies, are tabulated. 35 references are given also. (M.L.S.)

30157 (PRV-(66)45(Sect.1)) REATTORE VELOCE PROVA ELEMENTI COMBUSTIBILI (P.E.C.). Progetto di Massima. Sezione I. (Fuel Element Testing Fast Reactor (P.E.C.). Preliminary Design. Section I). (Comitato Nazionale per l'Energia Nucleare, Bologna (Italy)). July 31, 1966. 67p. (In Italian). Dep.

A general description of the fast reactor P.E.C. is given. Core characteristics are tabulated; neutron shielding and reflector characteristics are listed. Cooling system parameters are given; reactivity coefficients are tabulated. Test facilities are described. Neutron flux profiles are shown for experimental channels and test facilities. Fuel element and core loading diagrams are included. Drawings for the containment vessel are shown; diagrams of coolant circuits are given. Nuclear instrumentation diagrams are shown. (M.L.S.)

30158 (STI/PUB-163) HEAVY-WATER POWER REACTORS. Proceedings Series. Proceedings of a Symposium held in Vienna, 11–15 September 1967. (International Atomic Energy Agency, Vienna (Austria)). 1968. 981p. (In several languages). (CONF-670917). IAEA: $20.00; Austrian Schillings 517,-; £ 8.6.8; F Fr 98,-; DM 80,-.

Fifty-seven papers are presented on the subject of heavy water reactors. Discussion includes: reactor control, reactor safety, fuel economics, engineering and design, and heat transfer systems. Separate abstracts are present for fifty-five papers. Two papers were previously abstracted and appear as NSA 22: 18472 and NSA 22: 18482. (D.C.C.)

For abstracts of individual papers see: 28891, 30222–30271, 30314, 30327, 30330, and 30338.

30159 (SWRI-1228-P-9-15) INFLUENCE OF NEUTRON IRRADIATION ON THE PROPERTIES OF STEELS AND WELDS TYPICAL OF THE ERR PRESSURE VESSEL AFTER TWO POWER YEARS OPERATION. Ireland, D. R.; Norris, E. B. (Southwest Research Inst., San Antonio, Tex.). Mar. 1968. Contract AT(11-1)-1228. 103p. Dep. CFSTI.

As a part of the Elk River Reactor (ERR) Surveillance Program, a study has been made of the effects of neutron irradiation on the tensile, impact, and fatigue properties of steels and welds typical of those in the ERR pressure vessel. The test specimens utilized have been exposed to neutron fluence that is equivalent to what the vessel is expected to have received after 4½ full power years of operation. The results of tests on irradiated tensile and fatigue specimens are compared with those from the previous surveillance specimens and with the unirradiated properties. Charpy V-notch

impact curves were determined for irradiated materials so that the shift in the fracture transition temperature of the ERR pressure vessel could be estimated. The results of these tests are reviewed with respect to the estimated operating conditions (temperature, time, and fluence) of the ERR pressure vessel. (auth)

30160 (TID-3525(Rev.5)(Suppl.3)) REACTOR SAFETY. A Literature Search. Raleigh, Henry D. (comp.) (Division of Technical Information Extension (AEC), Oak Ridge, Tenn.). May 1968. 47p. Dep. CFSTI.

Included are 677 references to reports on various safety aspects of nuclear reactor design, operation, systems, components, and materials covering the period from September 1965 through December 1966. The major aspects considered are: comprehensive hazards analyses to satisfy construction and operation permit requirements; operational control systems and procedures; fission product release, containment, and removal; coolant void and loss of coolant consequences; evaluation of materials; and experimental simulation of hypothetical reactor accidents. Author, reactor, and report number-availability indexes are included. (auth)

30161 (WAPD-T-1950) SENSITIVITY OF THERMAL REACTOR STUDIES TO FISSION NEUTRON AND GAMMA SPECTRA. Harris, D. R. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Sept. 1966. Contract AT-11-1-GEN-14. 9p. (CONF-661001-56). Dep. CFSTI.

From 14th Conference on Remote Systems and Technology, Pittsburgh, Pa.

The sensitivity of reactivity and other design parameters to uncertainties in fission neutron and prompt γ spectra are examined for representative thermal power reactors. (auth)

30162 (WCAP-3680-6) CONTROL OF XENON INSTABILITIES IN LARGE PWR'S SEMI-ANNUAL PROGRESS REPORT FOR THE PERIOD ENDING MARCH 31, 1968. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). Apr. 1968. Contract AT(30-1)-3680. 15p. (EURAEC-2008). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

A one-dimensional diametral transient analysis of azimuthal xenon transients in large pressurized water reactors is presented. Hot channel factors are shown as a function of time after perturbation; both radial and axial hot channel factors are shown. (M.L.S.)

30163 (WCAP-3680-20) XENON-INDUCED SPATIAL INSTABILITIES IN LARGE PRESSURIZED WATER REACTORS. Poncelet, Claude G.; Christie, Alan M. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). Mar. 1968. Contract AT(30-1)-3680. 203p. (EURAEC-1974). Dep. CFSTI.

Work performed under United States–Euratom Joint Research and Development Program.

The characteristics of free-running xenon-induced spatial oscillations in large pressurized water reactors (PWR's) are investigated both from a phenomenological point of view and from the standpoint of the theoretical and calculational methods employed in their analysis. The digital simulation of spatial xenon instabilities with multidimensional, multi-group diffusion theory programs is investigated in detail. An extensive study of the effect of a finite, non-zero time-step length on calculated stability characteristics is presented, including a set of correlations which permits the extrapolation of digital calculations to effectively zero time-step length. The sensitivity of the digital results to the spatial mesh length, the energy mesh, and the treatment of temperature feedback effects is investigated. The effect of a non-zero flux convergence criterion on spatial xenon oscillations is investigated. A comparison is made of modal theory results and digital simulation calculations. The space-dependent transfer function formalism is employed in a number of analyses, including the effect of delayed neutrons and the effect of finite temperature feedback time-lags. The space-time characteristics of xenon-induced instabilities in the two-dimensional plane perpendicular to the direction of coolant flow are studied for a large variety of core sizes, power distributions and temperature feedback effects. The effect of perturbation size and location is evaluated. Extensive parametric and sensitivity analyses are performed, based on a modal expansion method. Parameters investigated are core size, power distribution, power level, power coefficient, fuel enrichment, Xe-135 absorption cross section, I-135 fission yield and direct Xe-135 fission yield. Parametric calculations with one- and two-dimensional diffusion theory programs are performed to corroborate the modal theory results. 33 references. (auth)

30164 (WCAP-3703) LARGE CLOSED-CYCLE WATER REACTOR RESEARCH AND DEVELOPMENT PROGRAM. Progress Report, December 1, 1960–May 31, 1961. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). Contract AT(30-1)-3064. 273p. Dep. CFSTI.

REACTORS, PRESSURIZED-WATER—development during December 1960 to May 1961, description of; moderator efficiency of, effects of boron concentration, water density, and temperature on; fuel elements for, fabrication of type 304 stainless steel-clad enriched uranium oxide (UO_2) pellet-type; core configuration for, design analysis for optimum; core support for, analysis of stress testing of stainless steel

REACTIVITY—effects of moderator density, temperature, and boron concentration on pressurized-water reactor, computer program analysis of

URANIUM-235—measurement of Doppler parameters for resonances in, method for measurement of

REACTOR CONTROL ELEMENTS—reactivity worth of cadmium–indium–silver, measurement of; fabrication of pressurized-water reactor cadmium–indium–silver, description of; testing of pressurized-water reactor cadmium–indium–silver, analysis of thermal and wear

SILVER ALLOY SYSTEMS—Ag–Cd–In, absorption properties of control elements of, measurement of

REACTOR CONTROL SYSTEMS—detector pattern efficiency for pressurized-water reactor, analysis of neutron

NEUTRONS—flux measurement efficiency in pressurized-water reactors, analysis of detector patterns for

REACTOR FUEL ELEMENTS—burnup efficiency of pressurized-water reactor enriched uranium oxide (UO_2) pellet-type, computer analysis; fabrication of pressurized-water reactor type 304 stainless steel-clad enriched uranium oxide (UO_2) pellet-type, description of; assemblies of type 304 stainless steel-clad enriched uranium oxide (UO_2) pellet-type, fabrication and thermal testing of pressurized-water reactor

STAINLESS STEEL—cladding of type 304, fabrication of pressurized-water reactor fuel elements

URANIUM OXIDES UO_2—fuel fabrication of enriched, fabrication of pressurized-water reactor pellet-type

REACTOR MODERATORS—effects of boron concentration, temperature, and density in efficiency of pressurized water

WATER—chemical analysis for pressurized-water reactor, description of coolant loop corrosion

IODINE-131—concentration in pressurized-water reactor coolant, ion exchange analysis of (D.C.C.)

30165 (WCAP-3706) LARGE CLOSED-CYCLE WATER REACTOR RESEARCH AND DEVELOPMENT PROGRAM. Progress Report, June 1, 1961–August 31, 1961. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). Contract AT(30-1)-3064. 209p. Dep. CFSTI.

REACTORS, PRESSURIZED-WATER—development during June to August 1961, description of; moderator efficiency of, effects of boron concentration, water density, and temperature on; core lifetime for, computer program for burnup analysis of

WATER—moderator temperature reactivity coefficient for pressurized-water reactor coolant, effects of boron concentration on; chemical analysis of pressurized-water reactor, for coolant loop corrosion studies

REACTOR FUEL ELEMENTS—burnup of pressurized-water reactor type 304 stainless steel-clad enriched uranium oxide (UO_2), computer analysis of; stress analysis of pressurized-water reactor type 304 stainless steel-clad enriched uranium oxide (UO_2) pellet-type; assemblies of type 304 stainless steel-clad enriched uranium oxide (UO_2) pellet-type, hydraulic and thermal testing of pressurized-water reactor

REACTIVITY—effects of moderator density, temperature, and boron concentration on pressurized-water reactor, computer program analysis of

STAINLESS STEEL—cladding of type 304, fabrication of pressurized-water reactor fuel elements

URANIUM OXIDES UO_2—fuels of enriched, fabrication of pressurized-water reactor pellet-type

SILVER ALLOYS AND SYSTEMS—Ag–Cd–In–Pt, metallurgical properties of, effects of annealing temperature on; Ag–Cd–In–Pd, metallurgical properties of, effects of annealing temperature on; Ag–Cd–In–Pd–Sn, metallurgical properties of, effects of annealing temperature on

REACTOR CONTROL ELEMENTS—drives for pressurized-water reactor cadmium–indium–silver, description of shock absorber and three-coil

COBALT-60, MANGANESE-54—concentration in pressurized-water reactor coolant, ion exchange analysis of (D.C.C.)

30166 (WCAP-3707) LARGE CLOSED-CYCLE WATER REACTOR RESEARCH AND DEVELOPMENT PROGRAM. Progress Report, September 1, 1961–November 30, 1961. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). Contract AT(30-1)-3064. 180p. Dep. CFSTI.

REACTORS, PRESSURIZED-WATER—development during September to November 1961, description of; criticality

equations for, analysis of; startup of, analysis of coolant loop
REACTOR CONTROL ELEMENTS—reactivity worth of pressurized-water reactor, analysis of, (T); cooling system for pressurized-water reactor three-coil positioned, performance of forced air
REACTIVITY—effects of moderator density, temperature, and boron concentration on pressurized-water reactor, computer program analysis of
STAINLESS STEEL—cladding for pressurized water reactor fuel elements of type 304, fabrication and irradiation testing of
ZIRCALOY—cladding for pressurized-water reactor fuel elements of, thermal and wear testing of
SILVER ALLOYS AND SYSTEMS—Ag–Cd–In–Sn, mechanical properties of, effects of annealing temperature on; Ag–Cd–In–Pd–Sn, mechanical properties of, effects of annealing temperature on
WATER—chemical analysis of pressurized-water reactor coolant, use of ion exchange analysis for
BENZENEBORONIC ACID—effects on pressurized-water reactor coolant loop crud, analysis of
HEAT TRANSFER SYSTEMS—performance of pressurized-water reactor, analysis of startup (D.C.C.)

30167 (WCAP-3708) LARGE CLOSED-CYCLE WATER REACTOR RESEARCH AND DEVELOPMENT PROGRAM. Progress Report, December 1, 1961–February 28, 1962. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). Contract AT(30-1)-3064. 197p. Dep. CFSTI.
REACTORS, PRESSURIZED-WATER—development during December 1961 to February 1962, description of; fuel elements of, analysis of temperature effects on power density in type 304 stainless steel-clad uranium oxide (UO_2) pellet-type
REACTOR CONTROL ELEMENTS—reactivity worth of Yankee Power Reactor, effects of boron concentration on; drives for pressurized-water reactors, description of
YANKEE POWER REACTOR—control elements reactivity worth, effects of boron concentration on; ionization chambers for, analysis of performance of
REACTOR FUEL ELEMENTS—neutron flux distribution in pressurized-water reactor type 304 stainless steel-clad uranium oxide (UO_2) pellet-type, effects of temperature on
RADIATION DETECTORS, IONIZATION CHAMBER—performance of Yankee Power Reactor, analysis of
SILVER ALLOYS AND SYSTEMS—Ag–Cd–In, tensile properties of control elements of, effects of annealing temperature on; Ag–Cd–In–Pt, tensile properties of control elements of, effects of annealing temperature on; Ag–Cd–In–Pd, tensile properties of control elements of, effects of annealing temperature on; Ag–Cd–In–Pt–Sn, tensile properties of control elements of, effects of annealing temperature on; Ag–Cd–In–Pd–Sn, tensile properties of control elements of, effects of annealing temperature on
STAINLESS STEEL—cladding for fuel elements type 304, stress analysis of
WATER—chemical analysis of pressurized-water reactor, for coolant loop, corrosion studies
COBALT-60, COBALT-58, MANGANESE-54, IRON-59, CHROMIUM-51—concentration in pressurized-water reactor coolant loop of, ion exchange analysis of
BENZENEBORONIC ACID—effects on pressurized-water reactor coolant loop crud, analysis of
REACTIVITY—effects of control system response on pressurized-water reactor, analysis of
REACTOR CONTROL SYSTEMS—performance of pressurized-water reactor, effects of response on
CRITICALITY STUDIES—core configurations for pressurized-water reactor, description of (D.C.C.)

30168 (WCAP-3710) LARGE CLOSED-CYCLE WATER REACTOR RESEARCH AND DEVELOPMENT PROGRAM FOR THE PERIOD MARCH 1, 1962–JUNE 30, 1962. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). Contract AT(30-1)-3064. 267p. Dep. CFSTI.
REACTORS, PRESSURIZED-WATER—development during March to June 1962, description of; fuel assemblies for, computer analysis for optimum burnup in
REACTOR FUEL ELEMENTS—burnup of pressurized-water reactor type 304 stainless steel-clad uranium oxide (UO_2) pellet-type, computer analysis for optimum; performance of pressurized-water reactor type 304 stainless steel-clad uranium oxide (UO_2), effects of nucleate boiling on
REACTOR CONTROL ELEMENTS—performance of pressurized-water reactor, computer analysis of optimum; reactivity worth of pressurized-water reactor, measurement of; creep properties of cadmium–indium–silver, effects of drop tests on; drives for pressurized-water reactors, development of sequencing variable speed
REACTOR CONTROL SYSTEMS—performance of pressurized-water reactor, error analysis for, (T)
HEAT TRANSFER SYSTEMS—performance of pressurized-water reactor, computer analysis of thermal; coolant performance in pressurized-water reactor, analysis of flow oscillations for measurement of
SILVER ALLOYS AND SYSTEMS—Ag–Cd–In, creep properties of control elements of, analysis of effects of drop tests on
COBALT-60, COBALT-58, MANGANESE-54—concentration in pressurized-water reactor coolant loop of, ion exchange analysis of
BENZENEBORONIC ACID—effects on pressurized-water reactor coolant loop crud, analysis of
CRITICALITY STUDIES—core configuration mockup for pressurized-water reactor, effects of fuel enrichment and boron concentration on, (E/T)
REACTIVITY—measurement of pressurized-water reactor core mockup, effects of fuel enrichment and boron concentration on, (E/T)
BOILING—effects of nucleate, in performance of type 304 stainless steel-clad uranium oxide (UO_2) fuel elements in pressurized-water reactors (D.C.C.)

30169 A CHRONOLOGY OF THE POWER AND ENERGY ECONOMY FOR THE GERMAN INDUSTRY-MESSE HANNOVER 1968. NUCLEAR ENERGY PRODUCTION. Jaroschek, K. Brennst.-Waerme-Kraft, 20: 145-9(Apr. 1968). (In German).

Energy production costs for nuclear power plants in Germany are compared with petroleum fired power plants. A chronology of German nuclear power plants is given; a brief history of development of various types of reactors is outlined. Some problems associated with nuclear power reactors are considered briefly. 62 references. (M.L.S.)

30170 ANALYSIS OF A WATERLOGGED FUEL ELEMENT SUBJECTED TO A POWER EXCURSION. Coffman, W. A.; Dunckhorst, F. T.; Lynn, L. L.; Meyer, J. E. (Westinghouse Electric Corp., West Mifflin, Pa.). Nucl. Appl., 4: 372-81(June 1968). (WAPD-T-2072).

A method was developed for predicting excessive clad sheath distortion in a cylindrical waterlogged reactor fuel element subjected to a transient increase in power. The analytical model includes heat transfer, linear elastic stress and deformation, and defect flow equations to yield transient values of internal pressure, clad stress, and clad strain. Details of the model and several comparisons with observed waterlogging incidents are given. (auth)

30171 ARE HEAVY-WATER REACTORS ON THE WAY OUT? Bahbout, Abraham. Euratom Rev., 7: No. 1, 10-17(Mar. 1968).

A description of heavy-water reactors is presented. Examples of pressurized-heavy water, boiling light water, pressurized gas, organic liquid, and pressure-vessel reactor with boiling heavy water are described, and main characteristics of each are presented. (D.C.C.)

30172 ATOMIC POWER: ITS INTEGRATION INTO A POWER SYSTEM WHICH IS DOMINATED BY WATER POWER. Wivstad, Ingvar (Statens Vattenfallsverk, Vaellingby, Sweden). Tek. Ukebl., 115: No. 11, 240-7(Mar. 14, 1968). (In Swedish).

Norway has hardly developed one half of its economically exploitable water power. Sweden has already used at least three quarters of its available water power. This means that atomic power will have to be used in Sweden on a larger scale earlier than in Norway. The Swedish plans for the development of atomic power in the 1970's and the questions that arise in connection with the integration of atomic power into a system which is dominated by water power are presented. The two first of the contributions to the discussion which followed the lecture are also given. (Norway)

30173 BRADWELL REACTOR COOLANT CHEMISTRY. PART I. GENERAL OBSERVATIONS. Godfrey, W. R.; Phennah, P. J. (Central Electricity Generating Board, Bradwell, Eng.). J. Brit. Nucl. Energy Soc., 7: 151-7(Apr. 1968).

Operation of the two carbon dioxide cooled graphite-moderated reactors at Bradwell provided an accumulation of data derived from chemical analysis of the reactor coolants. These data embrace both normal and transient operating conditions, and include the results of special investigations designed to further an understanding of some of the complex chamical processes occurring within the reactor core. General features of Bradwell reactor coolant chemistry are described. (auth)

30174 BRITAIN'S NEW COMPETITIVE NUCLEAR POWER SYSTEM. Boltz, C. L. Spectrum, No. 47: 6-8(1968).

An account is given of the Steam Generating Heavy Water Reactor (SGHWR) at Winfrith Heath (United Kingdom Atomic Energy Authority), which is generating 100 MW(e) and supplying most of this to the national grid system. (UK)

30175 CARBON TRANSPORT IN THE THTR AND AVR HIGH TEMPERATURE REACTORS. Stolz, E. (Brown, Boveri/Krupp Reaktorbau GmbH, Mannheim, Ger.); Werner, F. L. Atomwirt., Atomtech., 13: 99-103(Feb. 1968). (In German).

The mechanisms of graphite corrosion in high temperature gas cooled reactors is discussed; the reaction kinetics are detailed. The volume reaction rate is shown as a function of fuel pebble radius and temperature. Carbon deposition is considered; effects of temperature on carbon deposition are shown. The design of a gas purifying installation is described; some parameters are given. 17 references. (M.L.S.)

30176 CHEMICAL ASPECTS OF THE REACTIVITY COMPENSATION BY HOMOGENEOUS POISONING OF A NUCLEAR REACTOR. Dolle, L.; Dirian, G. pp 187-218 of La Chimica dell'Acqua nei Reattori Nucleari. Rome, Comitato Nazionale Energia Nucleare, 1966. (In French).

From Symposium on Water Chemistry in Reactors, Rome. See CONF-213.

The principle of compensation of the xenon effect by homogeneous poisoning of the reactor is described. The factors governing the selection of the soluble poison are outlined. Concentration of soluble poison in the reactor is compared with the xenon poisoning buildup. The fixation of the soluble poisons of B, Cd, Li, and Gd is shown graphically. The irreversible fixation of poison on metallic surfaces is considered. The effect of the soluble poison on the rate of water radiolysis is discussed. The data obtained lead to the conclusion that the compensation of the xenon effect in a large power reactor is possible by homogeneous poisoning of the moderator. The most favorable soluble poisons are B, Cd, natural Gd, and ^{6}Li. (J.S.R.)

30177 COMMISSIONING AND INITIAL OPERATION OF THE MZFR. Sparhuber, R. (Technische Stammabteilung Energieversorgung, Erlangen, Ger.). Atomwirt., Atomtech., 13: 130-4 (Mar. 1968). (In German).

After surveying the course of commissioning, the special investigations which were carried out on the MZFR and the operating behavior of the installation are described. Particular attention is paid to the experiments to prove the operational safety of the installation, other physical investigations, trials with the main pumps for the cooling medium, investigations of the emergency cooling system and the particularly comprehensive program to determine the dynamic characteristics of the installation. (TSS) (auth)

30178 COMMISSIONING OF THE KWL. Jaerschky, R. (Kernenergieanlagen, Frankfurt am Main). Atomwirt., Atomtech., 13: 142-3(Mar. 1968). (In German).

The commissioning procedures followed for the Lingen nuclear power plant are described. The three phases followed were: preoperational testing during the final construction stages, zero power experiments and fuel loading, and one month of test operation at power. (H.D.R.)

30179 COMMISSIONING THE WINFRITH SGHWR. Cartwright, H. (United Kingdom Atomic Energy Authority, Risley, Eng.). Nucl. Eng., 13: 416-7(May 1968).

The various stages of the commissioning programme are briefly described. Minor incidents occurring, which are summarised, include leakage across a superheat channel liner, D_2O leakage from a cooler, and primary circuit clean-up troubles. (UK)

30180 CONTROL OF THE NUCLEAR POWER STATION LINGEN. Reinhardt, A. (Kernenergieanlagen, Frankfurt am Main). Atomwirt., Atomtech., 13: 161-3(Mar. 1968). (In German).

The pressure, temperature, and flow control systems for the Lingen station reactor, superheater, and turbines are described, and typical performance data under various conditions are diagrammed. (H.D.R.)

30181 CONSTRUCTION OF THE COMPLETE KWL PLANT. Schmoczer, R. (Kernenergieanlagen, Frankfurt am Main). Atomwirt., Atomtech., 13: 146-50(Mar. 1968). (In German).

The Lingen nuclear power station reactor and conventional plant buildings are described, and the heat transfer circuits, water supply system, and electrical supply system are diagrammed. (H.D.R.)

30182 DESIGN FROM THE SAFETY POINT OF VIEW OF THE BOILING-WATER REACTOR TO PREVENT BREAKAGE IN THE PRIMARY CIRCUIT. Traube, Klaus (Allgemeine-Elektricitaets-Gesellschaft, Frankfurt am Main). At. Strom., 14: 27-36(Feb.-Mar. 1968). (In German).

The design safety of a boiling reactor primary circuit and containment vessel is presented. Incidents requiring pressure reduction, emergency cooling of the core, and prevention of primary circuit breakage are described. (tr-auth)

30183 ENGINEERING INSPECTION OF NUCLEAR POWER PLANTS. Crossley, E. Atoomenergie Haar Toepass., 10: 76-82(Mar. 1968).

The standards of design, construction, and testing of steel vessels and heat-exchanger shells for gas-cooled, graphite-moderated power reactors are reviewed. (H.D.R.)

30184 FORMATION AND IMPORTANCE OF THE NUCLEAR POWER STATION LINGEN. Deublein, O. (Kernkraftwerk Lingen GmbH, Strasse, Ger.). Atomwirt., Atomtech., 13: 138-41(Mar. 1968). (In German).

The initial planning, site description, financing, and operational organization of the Lingen nuclear power station are discussed. The 240 MW(e) plant with a boiling water reactor and an oil fired superheater is located in district of Darme near the town of Lingen. The capital cost of construction was 270 million DM, and the plant was constructed and is being operated by the Kernkraftwerk Lingen GmbH. (H.D.R.)

30185 FUTURE OF WATER-COOLED REACTORS FOR THE PRODUCTION OF ELECTRIC POWER. Pelser, J. (Reactor Centrum Nederland, Petten, Netherlands). Atoomenergie Haar Toepass., 10: 72-6(Mar. 1968). (In Dutch).

Calculations are presented to show that present nuclear power plants employing PWR-reactors produce cheaper electricity than do conventional power plants. Fast breeder reactors are suggested as the most favorable power source for the future. (JJtB)

30186 HEAT-TRANSFER ANALYSIS IN LOSS-OF-COOLANT ACCIDENTS. Walters, Craig T.; Genco, Joseph M.; Raines, Gilbert E. (Battelle Memorial Inst., Columbus, Ohio). Nucl. Eng. Design, 7: 123-40(1968).

A computer program has been written for the comprehensive analysis of core-pressure-vessel heat transfer during a loss-of-coolant accident. The program, NURLOC-1.0, is based upon a generalized procedure for numerically solving the two-dimensional heat-conduction equation over multi-connected regions with various complicating factors specific to this application. The numerical procedure consists of solving the explicit finite-difference form of the conduction equation at mesh intersections. Boundary conditions and heat-generation rates are set by models that characterize various complex chemical and physical processes which can occur during an accident. The processes considered in NURLOC-1.0 include boil-off of residual coolant water, metal-water reactions, radiative exchange, and material transport as a result of melting in addition to the usual conditions of convection, fission-product-decay heating, and delayed-neutron heating. (auth)

30187 IMPORTANT TECHNICAL DATAS OF THE NUCLEAR POWER STATION LINGEN (KWL). Atomwirt., Atomtech., 13: 144-5(Mar. 1968). (In German).

Equipment, material, and operating parameter specifications are tabulated for the Lingen station reactor, fuel elements, control elements, heat transfer system, and conventional power plant equipment. (H.D.R.)

30188 LIQUID SHUT-DOWN SYSTEM: WINFRITH SGHWR. Shaw, M. K. (English Electric Co., Whetstone, Eng.). Nucl. Eng., 13: 418-20(May 1968).

Problems encountered in the design of the system are discussed. The finalised design which is described consists of twelve shut-down loops each comprising a U-tube, main shut-down valve, high pressure head tank, and a buffer tank. A trip signal actuates the valve and allows absorber to be forced from the pressurized header tank up into a tube in the calandria. The fluid column is arrested by a vent tube and buffer tank which are connected to the top of the calandria tube. Typical performance curves are shown. The special valve, designed to open in 0.1 sec, is described. (UK)

30189 LIST OF INDUSTRIAL CONTRACTORS AND SUPPLIERS FOR THE KWL. Atomwirt., Atomtech., 13: 158-60 (Mar. 1968). (In German).

The various firms that participated in the design, nuclear and conventional construction, and supply of electrical and mechanical equipment for the Lingen nuclear power station are listed. (H.D.R.)

30190 MATERIALS FOR CONTROL OF WATER COOLED POWER REACTORS. Pashos, T. J. (General Electric Co., San Jose, Calif.). Nucl. Appl., 4: 395-8(June 1968).

The control rod requirements of water cooled power reactors have been satisfied thus far with the successful operation of control rod systems containing B_4C in tubes, Ag–In–Cd alloy, hafnium, or Eu_2O_3 dispersed in stainless steel. Additional auxiliary control is being obtained through the use of burnable poison materials such as boron, erbium, and gadolinium. (auth)

30191 MEASUREMENT OF BALL PATHS WITH REFERENCE TO THE MOVEMENT OF FUEL ELEMENTS IN THE CORE OF A PEBBLE BED REACTOR. Bedenig, D. (Brown Boveri/Krupp Reaktorbau Gmbh, Juelich, Ger.). Kerntechnik, 10: 230-2(Apr. 1968). (In German).

Knowledge of the flow behavior of the pebble bed is one of the prerequisites for the full utilization of the advantages of the gas-cooled high temperature reactor of the pebble bed type. Measurements and calculations relating to this behavior require the prior determination of the paths of the individual fuel elements. The results of measurements of bead paths obtained in a glass bead model of the core of a pebble bed reactor are presented. (auth)

30192 MINIMISING THE HAZARDS ASSOCIATED WITH THE USE OF THE DOUNREAY FAST REACTOR AS AN IRRADIATION FACILITY. Phillips, J. L. (Dounreay Experimental Reactor Establishment, Scotland). Bull. Inform. Sci. Tech. (Paris), No. 124: 51-62(Mar. 1968). (In French).

The Dounreay Fast Reactor, a power demonstration unit, has acquired an important role as an irradiation reactor. The operation as a power unit has led only to minor difficulties which were successfully overcome. The use of the reactor as an irradiation facility made continuous control necessary. The probability of failure due to experiments cannot be entirely assessed. Procedures have been evolved to minimize it. The reactor has produced 39,000 MWD thermal power and 194,000 MWH electrical power. 450 irradiation experiments have been conducted. (auth)

30193 METHOD OF ASSESSING FAST REACTOR SAFETY. Farmer, F. R.; Gilby, E. V. (United Kingdom Atomic Energy Authority, Risley, Eng.). Bull. Inform. Sci. Tech. (Paris), No. 124, 17-28(Mar. 1968). (In French).

A logical method of reactor safety assessment based upon the numerical evaluation of risk is described. The application of the method to fast reactors is discussed and this highlights the relative importance of accident prevention methods, the protective system and containment measures. The detailed discussion makes reference to some of the more important technical problems and to a number of the particular points mentioned in the programme. (auth)

30194 NUCLEAR ENERGY AT THE THRESHOLD OF ECONOMIC UTILIZATION. Mandel, H. (Vorstandsmitglied der Rheinisch-Westfaelisches Elektrizitaetswerk AG, Essen). Atomwirt., Atomtech., 13: 23-31(Jan. 1968). (In German).

Development of nuclear energy in the German Federal Republic is discussed; predictions to 1980 are made. Energy production costs for oil-fired and nuclear power plants are compared. Economic effects of reserves of the natural resources are analyzed. (M.L.S.)

30195 NUCLEAR POWER STATIONS IN POPULATED AREAS. Marnet, Chrysanth. BBC-Nachr., 49: 363-6(1967). (In German).

The importance of siting of power reactors is evaluated. Determination of population dose rates and establishment of standards are discussed. The characteristics and requirements for pressure and containment vessels for pressurized-water and carbon dioxide-cooled graphite-moderated power reactors are analyzed. The accident analysis methods utilized by the U. S., Canada, and Britain are described. (8 references) (M.L.S.)

30196 NUCLEAR POWER STATIONS WITH BOILING WATER REACTORS: CONSTRUCTION AND SAFETY ASPECTS. Kornbichler, Heinz (Fachgebietes Kernreaktoren, Frankfurt am Main). At. Strom., 14: 21-6(Feb.-Mar. 1968). (In German).

The safety aspects of construction and operation of boiling water power reactors are presented. Schematic diagrams of systems are presented. The power plant safety provides siting near thickly populated areas. (tr-auth)

30197 ON THE INVESTIGATION OF HAIR CRACKS IN THE JPDR PRESSURE-VESSEL OVERLAY CLADDING, AND THE COUNTERMEASURES. Kawasaki, Masayuki (Japan Atomic Energy Research Inst., Tokyo). Genshiryoku Kogyo, 13: No. 12, 35-42(Dec. 1967). (In Japanese).

Results of investigations for the cause of hair cracks in the JPDR pressure vessel are presented. During the pad-welding process minute defects were formed at the grain boundaries of high-temperature deposit metal. The investigation and studies and the countermeasures in this connection are described. (NSA of Japan)

30198 PERFORMANCE OF Ag–In–Cd IN PRESSURIZED WATER REACTORS. Smalley, W. R. (Westinghouse Electric Corp., Pittsburgh). Nucl. Appl., 4: 432-9(June 1968).

An alloy composed of 80% Ag, 15% In, and 5% Cd was selected for the first commercial pressurized water reactors on the basis of its attractive nuclear properties, ease of fabrication, and low relative cost. Representative samples of a nickel-plated Ag–In–Cd control rod from Yankee Core I showed that the plating had not protected the base metal from the reactor coolant. However, the alloy displayed good irradiation stability, as evidenced by only minor changes in dimensions, microstructure, and mechanical properties. Stainless steel clad Ag–In–Cd absorbers have performed well in several reactors, both as cruciform arrays of cylindrical rods and as clusters of rods arranged in concentric rings. (auth)

30199 PERFORMANCE OF BORON-CONTAINING CONTROL RODS IN WATER COOLED POWER REACTORS. Mefford, C. R.; Williamson, H. E. (General Electric Co., San Jose, Calif.). Nucl. Appl., 4: 425-31(June 1968).

Boron-containing materials for which fabrication processes are described include boron dispersions in iron, boron-stainless steel alloys, and boron carbide-filled stainless steel tubes. Experience with both satisfactory and less-than-satisfactory materials and fabrication procedures is briefly documented. The present performance of boron carbide-filled tubes, sheathed to make a cruciform control rod, is satisfactory, and continuing improvements are expected. (auth)

30200 PLUTONIUM: TOMORROW'S FUEL. Mattys, Henri (European Transuranium Inst., Karlsruhe, Ger.). Euratom Rev., 7: No. 1, 2-9(Mar. 1968).

The potentials of using plutonium as a fuel in nuclear reactors are described. Fabrication of PuO_2–UO_2 fuel pellets is described, and thermal properties of the fuel are presented. Handling difficulties are described. (D.C.C.)

30201 POWER DEMAND AND NUCLEAR POWER IN FINLAND. Hultin, S. O. Ekon. Samf. Tidskr., 20: 27-38(1967). (In Swedish).

The power demand in Finland is estimated for the next 15 years. The annual power increase in 1965 was 10 percent or 250 MW/year, and the rate of increase for 1980 is supposed to be 6.5 percent or 400 MW/year. Cost comparisons between nuclear and fossil fuels favour nuclear fuels. In 1964 a mixed governmental-industrial committee was established. The committee released a proposal in June 1966 recommending construction of the first nuclear power plant ready for operation in 1971, that the Imatran Voima Oy (Imatra Power Ltd.) would receive the commission for the plant in close cooperation with other industrial or community parties to avoid superfluous planning, and the site recommended was located south-east of the town of Lovisa. (Sweden)

30202 PROPAGATION OF FUEL MELTING IN A FAST REACTOR USING A CERAMIC FUEL. Stievenart, M.; Renard, A. (BELGONUCLEAIRE, Brussels). Bull. Inform. Sci. Tech. (Paris), No. 124, 3-16(Mar. 1968). (In French).

The code PROFUSION permits to study the propagation of fusion in the ceramic fuel pins of fast reactor and the reactivity variation which can be associated with a possible fuel slumping in the axial holes resulting from the migration of porosity in the virgin fuel. The temperature distributions of the coolant, fuel can and fuel are calculated. One calculates the core power limit, which initiates the fuel fusion. Afterwards the propagation of fuel melting is calculated when the core power limit is overpassed. For each configuration, molten fuel displacements are performed and the subsequent reactivity change is evaluated. The method has been used for the Enrico Fermi oxide core design and Rapsodie. (auth)

30203 RADIOACTIVITY AND WATER CHEMISTRY IN THE BOILING-WATER REACTOR. Wolff, Ulrich (AEG-Telefunken, Frankfurt am Main). At. Strom, 14: 49-51(Feb.-Mar. 1968). (In German).

The methods used in boiling-water nuclear power stations for controlling radioactive substances are discussed. It is shown that even if fuel damage occurs to an extent which has not even been approached in about 40 reactor operating years, and if unrestricted operation of the power station is continued the radioactive isotopes emitted from the power station are at the most in the maximum permissible concentrations. Release of radioactive substances in water can be prevented. Boiling-water reactor power stations of this design are independent of position from the safety standpoint. (auth)

30204 REACTOR STRATEGIES FROM THE POINT OF VIEW OF TRACE POLICY. Held, Chr. (STEWAG, Graz, Austria. Zeit der Abfassung Dieses Beitrages Siemens AG, Erlangen). Atomwirt., Atomtech., 13: 32-6(Jan. 1968). (In German).

An economic comparison is made between PWR, BWR, Magnox, ACR, and CANDU reactors; these are then compared with an oil-fired station. Balance of trade and trade policies of the various countries of the world are considered; industrial capacity is tabulated by country and classified as negligible industrial capacity, industrial countries, or super-industrial capacity. Economic con-

siderations for each type of country are based on type of power plant. (M.L.S.)

30205 REVIEW OF THE FERMI REACTOR FUEL DAMAGE INCIDENT AND A PRELIMINARY ASSESSMENT OF ITS SIGNIFICANCE TO THE DESIGN AND OPERATION OF SODIUM COOLED FAST REACTORS. McCarthy, Walter J. Jr. (Power Reactor Development Co., Monroe, Mich.); Jens, Wayne H. Bull. Inform. Sci. Tech. (Paris), No. 124, 29-50(Mar. 1968). (In French).

The status of the investigation of the extent and cause of the October 5, 1966 fuel damage at the Enrico Fermi sodium cooled fast breeder reactor is given as of September 13, 1967. A foreign object has been found in the core inlet plenum which is believed to have been the cause of the damage. The results of examinations of six damaged fuel subassemblies are given and some preliminary observations are made concerning possible improvements which may be made in the design of sodium cooled fast reactors to aid in the prevention, detection and recovery from similar incidents. (auth)

30206 SAFETY ASPECTS IN THE CONSTRUCTION, MANUFACTURE, AND TESTING OF IMPORTANT COMPONENTS IN THE BOILING-WATER REACTOR. Ullrich, Walter (AEG-Telefunken, Frankfurt am Main). At. Strom, 14: 42-9(Feb.-Mar. 1968). (In German).

Safety analysis and testing during construction of a boiling reactor are described. Stress testing of components is also described. (tr-auth)

30207 SAFETY ASPECTS OF THE DYNAMIC BEHAVIOUR OF THE BOILING-WATER REACTOR. Engel, Helmut (AEG-Telefunken, Frankfurt am Main). At. Strom, 14: 37-42(Feb.-Mar. 1968). (In German).

The dynamic reactor behavior of the boiling-water reactor is inherently safe. Faults and accidents are conceivable which are limited to such an extent by the protective system that the operating capacity of the power station is not adversely affected. Even if there is a failure of several independent safety systems and safety arrangements, the only result can be damage to the core, but no uncontrolled spread of activity into the surroundings of the power station can take place. (auth)

30208 SAFETY TECHNIQUES IN NUCLEAR POWER STATIONS WITH BOILING WATER REACTORS. Kornbichler, H. (Fachgebiet Kernreaktoren, Frankfurt am Main). Atomwirt., Atomtech., 13: 50-3(Jan. 1968). (In German).

The safety standards by which the Wuergassen Power Reactor is being designed are given. These are prepared as general standards for boiling water reactors. The basic considerations used in postulating the maximum credible accident are tabulated. (M.L.S.)

30209 SHOULD THE EUROPEAN COMMUNITY PRODUCE ITS OWN ENRICHED URANIUM? Michaelis, Hans. Euratom Rev., 7: No. 1, 24-9(Mar. 1968).

A description of fuel requirements for power reactors in the Euratom community is presented. Proposed power requirements between 1970 and 1980 are established, and discussion as to the types of reactors for power production is presented. A review of world-wide power requirements is presented, and an analysis of enriched uranium supply-and-demand status is discussed. Economic and legal aspects of European produced enriched uranium are presented. (D.C.C.)

30210 SOME PROBLEMS OF NUCLEAR POWER ENGINEERING. Petros'yants, A. M. Nukleonika, 13: 131-40(1968). (In Russian).

A short survey of Soviet developments in nuclear power, which lead to the peaceful applications of atomic energy, particularly in nuclear power engineering, is given. The experience gathered during the 13 years of operation of the first power plant in the world in Obninsk founded a basis for the construction of several new power plants of much higher power in which nuclear reactors of various types have been installed. Thus far, however, nothing points out that one of the reactors tested is distinctly superior to the other types, but it is believed, that after 1980 fast neutron reactors shall play a major role in nuclear power engineering. (auth)

30211 SPECIAL ASPECTS OF THE KWL BOILING WATER REACTOR. Engel, H.; Traube, K. (Kernenergieanlagen, Frankfurt am Main). Atomwirt., Atomtech., 13: 151-5(Mar. 1968). (In German).

The general Lingen reactor layout and the fuel element fabrication processes are described. Design features of the internal cyclone-type steam separators, control rod drives, and neutron-sensitive thermoelements for in-core power distribution measurements are examined. (H.D.R.)

30212 SPECIAL CIVIL CONSTRUCTION PROBLEMS AT THE KWL. Koerber, A. (AEG-Telefunken, Frankfurt am Main). Atomwirt., Atomtech., 13: 155-7(Mar. 1968). (In German).

The conventional part of the Lingen power station comprises a superheater building, stack, machine house, and the control building. Construction features of these facilities and of the cooling water canal are described. (H.D.R.)

30213 SPECIAL FEATURES OF THE CONVENTIONAL PART OF THE KWL. Moll, K. (Kernenergieanlagen, Frankfurt am Main). Atomwirt., Atomtech., 13: 164(Mar. 1968). (In German).

Special operation and control characteristics of the superheater, turbine, turbine divert station, secondary feed pumps, and coolant water supply system of the Lingen station are briefly described. (H.D.R.)

30214 THE 670 MW NUCLEAR POWER STATION WUERGASSEN WITH AEG BOILING WATER REACTOR. Ringeis, W. K. (Kernkraftwerksprojektierung, Frankfurt am Main). Atomwirt., Atomtech., 13: 40-9(Jan. 1968). (In German).

A complete description of the Wuergassen Power Reactor is given. A descriptive layout of the installation is shown; a generalized systems plan is given. Design and operating parameters are tabulated. First core reactivity balance and reactivity coefficients are listed. Brief descriptions of each of the systems are given. (M.L.S.)

30215 THE 670 MW NUCLEAR POWER PLANT WUERGASSEN WITH AEG BOILING WATER REACTOR. PART II. Ringeis, W. K. Atomwirt., Atomtech., 13: 95-8(Feb. 1968). (In German).

The electrical system for the Wuergassen Power Reactor is described; a circuit diagram is shown. Flow diagrams for the emergency cooling and spray systems and the steam and power conversion systems are given. A construction schedule for the whole installation is presented. (M.L.S.)

30216 THE U. S. PROGRAM ON THE LIQUID METAL FAST BREEDER REACTOR. Sweek, R. F.; Amorosi, A. Nucl. News, 11: No. 3, 45-9(Mar. 1968).

A description of the Liquid Metal Fast Breeder Reactor (LMFBR) development program is presented. A review of design studies, components, and safety requirements is presented. The proposed core design, fuel performance, cycle operation, and industrial capabilities are discussed. (D.C.C.)

30217 TURBINE HALL MODEL FLOW TESTS, WINFRITH SGHWR. Baker, P. J. (British Hydromechanics Research Association, Cranfield, Eng.); Leigh, K. M. Nucl. Eng., 13: 423-5(May 1968).

Model flow tests were used to assess the buffer action of the turbine hall between the vapor suppression system and the relief valves in the roof. Experiments were carried out over a wide range of burst gas flow rates and bouyancy levels with hot and cold air and a CO_2/air mixture. The results showed that the modified Froude number group $[gL/V^2]^a[\Delta\rho/\rho]^b$ characterized the results satisfactorily. A containment efficiency parameter, η, was defined as the ratio of the volume of burst gas entering the hall, prior to release of any burst gas through the relief vents, to the total volume of the hall. At low flow rates this parameter was reduced. (UK)

30218 THE WORLD'S REACTORS, No. 42: WINFRITH SGHWR. Nucl. Eng., 13: facing-420(May 1968).

A sectional view of the reactor building shows the arrangement of the plant. The main parameters are listed. (UK)

30219 STATUS AND PROSPECTS OF THE HELIUM TURBINE FOR HIGH-TEMPERATURE NUCLEAR POWER PLANTS. Bruett, P.; Sonnenschein, H. (Gutehoffnungshuette Sterkrade AG, Oberhausen, Ger.). Kerntechnik, 10: 185-97(Apr. 1968). (In German).

High-temperature reactors can be operated in two-cycle systems, e.g., in combination with a steam turbine, or in single-cycle systems, e.g., together with a helium turbine. The helium cycle is suitable for high turbine inlet temperatures with a relatively low pressure of the gas. Examinations have shown that the components of helium cycles, such as the turbine, compressors, coolers, heat exchangers and piping, can be built in sizes which are within the ordinary limits, even in the case of plants for high electric powers up to 1000 MW. By raising the turbine inlet temperature the plant efficiency can be increased to approximately 50%. For future energy programmes, the high-temperature reactor with helium turbine offers a good development potential because of the very high plant efficiency and the compact and relatively simple construction. (auth)

30220 THE CONTROL RODS OF THE OBRIGHEIM NUCLEAR POWER STATION AND THEIR DRIVE MECHANISMS. Knoedler, D.; Schabert, H. P. (Siemens Aktiengesellschaft, Erlangen, Ger.). Kerntechnik, 10: 217-25(Apr. 1968). (In German).

The design of the control rods, of the control rod guide system and of the control rod drive mechanisms for the Obrigheim nu-

clear power station is presented. The control rods are of the finger type, the drives are magnetic jacks with latches. The procedure for installing the drives and the handling of the control rods during refuelling, and reports on the results of tests on prototypes are also described. (auth)

30221 UNDERWATER CONTAINMENT FOR POWER REACTORS. Klepper, O. H.; Bell, C. G. (Oak Ridge National Lab., Tenn.). Nucl. Eng. Design, 7: 262-78(1968). (ORNL-P-3704).

The feasibility and potential advantages of containing large nuclear power reactors in underwater caissons is investigated. The reference design described consists of a 715 MW(e) boiling-water reactor housed in a concrete caisson located one-half mile offshore. The turbine-generator is located on a ten-acre artificial island, which surrounds the caisson. Seawater is employed for containment cooling and to reduce the outleakage of fission products in the event of a reactor loss-of-coolant accident. It is estimated that the activity release rates to the environment would be several orders of magnitude smaller than for the corresponding above-ground containment system. Significant contamination of the sea appears unlikely. It is suggested that this new containment approach be considered for power reactors near metropolitan areas that require augmented reactor safety and that are adjacent to a suitable lake, river, or ocean. A significant reduction of overall plant cost appears achievable at sites with high land values. (auth)

30222 HALDEN BOILING WATER REACTOR: PLANT PERFORMANCE AND HEAVY-WATER MANAGEMENT. Aas, S.; Jamne, E.; Wullum, T.; Fjellestad, K. (Institutt for Atomenergi, Halden, Norway). pp 3-23 of Heavy-Water Power Reactors. Vienna, International Atomic Energy Agency, 1968.

From Symposium on Heavy-Water Power Reactors, Vienna, Austria. See STI/PUB-163; CONF-670917.

The Halden boiling heavy-water reactor, designed and built by the Norwegian Institutt for Atomenergi, has been operated as an international project since June 1958. On its second charge the reactor was operated at power levels up to 25 MW and most of the time at a pressure of 28.5 kg/cm^2. During the period from July 1964 to December 1966 the plant availability was close to 64% including shutdowns because of test fuel failures and loading/unloading of fuel. Disregarding such stops, the availability was close to 90%. The average burnup of the core is about 6200 MWd/t UO_2; the most highly exposed elements have reached 10,000 MWd/t UO_2. The transition temperature of the reactor tank has been followed closely. The results of the surveillance programme and the implication on the reactor operation are discussed. The reactor is located in a cave in a rock. Some experiences with such a containment are given. To locate failed test-fuel elements a fuel failure location system has been installed. A fission gas collection system has saved valuable reactor time during clean-up of the reactor system following test fuel failures. Apart from one incident with two of the control stations, the plant control and instrumentation systems have functioned satisfactorily. Two incidents with losses of 150 and 200 kg of heavy water have occurred. However, after improved methods for leakage detection had been developed, the losses have been kept better than 50 g/h. Since April 1962 the isotopic purity of the heavy water (14 t) has decreased from 99.75 to 99.62%. The tritium concentration is now slightly above 700 μC/cm^3. This activity level has not created any serious operational or maintenance problems. An extensive series of water chemistry experiments has been performed to study the influence of various operating parameters on radiolytic gas formation. The main results of these experiments will be reported. Different materials such as mild steel, ferritic steel and aluminum have been used in the primary circuits. Experience with these materials is reported. (auth)

30223 BR3/VULCAIN NUCLEAR POWER STATION: CONSTRUCTION AND OPERATIONAL EXPERIENCE. Storrer, J. (BelgoNucleaire, S. A., Brussels). pp 25-37 of Heavy-Water Power Reactors. Vienna, International Atomic Energy Agency, 1968.

From Symposium on Heavy-Water Power Reactors, Vienna, Austria. See STI/PUB-163; CONF-670917.

A full-scale reactor experiment was set out as the main objective of the Vulcain research and development programme agreed in May 1962 between the UKAEA and BelgoNucléaire, manager of "Syndicat Vulcain." Vulcain uses variable moderation as the long-term method of control reactivity; the reactor is cooled and moderated by a mixture of heavy and light water, the D_2O content being stepwise reduced to permit power operation with all control rods completely out of the core. To carry out the Vulcain power experiment it was decided to modify the BR3 nuclear power plant located at Mol, Belgium, which had operated from 1962 to 1964 as a conventional PWR with outputs of 40.9 MW(th) and 11.45 MW(e). The BR3/Vulcain plant was started in December 1966 and since then is running with a load factor around 90%. D_2O is being used at a pressure (2000 lb/in.^{2} abs.) never before achieved in a heavy-water reactor and the leak rate from the HP primary systems to the atmosphere has been kept to a negligible value, around 1 to 2 grams/h. Commissioning of the primary plant has been carried out with light water first without fuel, and thereafter with fuel, at which time the water was poisoned with boric acid. The reactor vessel contains experimental devices such as 65 in-pile instrumentation detectors and four hydraulically operated Zircaloy control rods. They required the interposition of a collar between the vessel and its lid. Refuelling is performed under boronated light water, the interchange between the primary water and the H_2O being carried out by means of a draining and spraying system. The reactor had been operated for two years before its modifications for Vulcain: many lessons have therefore been learned about working on irradiated systems. The BR3/Vulcain core has a power density of 41 MW(th)t U. The expected average fuel burnup and core life are 25,000 MWd/t U and 620 equivalent full-power days, respectively. These characteristics have been achieved without taking advantage of improvements, such as the possibility of flattening the power distribution in the core by the use of two or more fuel enrichments, which are planned for more advanced Vulcain cores. The successful construction and operation of BR3/Vulcain will have demonstrated that components and techniques are available to build and operate simple, compact reactors in the small to medium power range, using long-life, high-power density cores and variable moderation. From the analyses carried out so far this concept competes well with other reactor concepts, while market surveys have indicated that there is a world market for small to medium power stations at prices within reach of those currently mentioned for the Vulcain design. (auth)

30224 NPD OPERATING EXPERIENCE. Horton, E. P. (Hydro-Electric Power Commission of Ontario, Rolphton). pp 53-65 of Heavy-Water Power Reactors. Vienna, International Atomic Energy Agency, 1968.

From Symposium on Heavy-Water Power Reactors, Vienna, Austria. See STI/PUB-163; CONF-670917.

NPD has demonstrated high-capacity factor operation and for the past three years has achieved an average net capacity factor of 98% for the "winter-peak" period. The net capacity factor for the year 1966 was 88% and for the period from the end of commissioning (October 1962) to the end of 1966 was 71%. The output of the station has been stretched from 22 MW(e) gross to 25 MW(e) gross. This was aided by the installation of an internal steam separator in the turbine but no basic modifications to the reactor-boiler systems were required. The turbine has also been modified by the installation of chrome steel diaphragms as a solution to an erosion problem. The station also continues as a test facility to develop new components and techniques. This includes the recent successful replacement of two reactor pressure tubes and the conversion of the reactor vault ventilation system to a "dry" atmosphere using a molecular sieve to collect heavy-water leakage and control the concentration of acidic oxides of nitrogen. Fuel performance has been excellent and the average burn-up in the core is now 84 MWh/kg U which is slightly above the equilibrium design value. Only three fuel bundles have been found with sheath failures and none of these was due to a deficiency in the fuel but was as a result of handling problems with the refuelling equipment. In spite of undesirably high maintenance time, the fuelling machines have now inserted over 1000 fuel bundles into the reactor "on power." Heavy-water loss rates have been acceptable and are improving. The average loss rate from leaks during 1966 was 210 g/h. A proposal to modify the NPD heavy-water transport system to allow boiling is under consideration. (auth)

30225 AGESTA REACTOR PLANT: OPERATIONAL EXPERIENCE FROM 1963 TO 1967. Ericsson, E.; Hasling, W. (Swedish State Power Board, Stockholm). pp 67-81 of Heavy-Water Power Reactors. Vienna, International Atomic Energy Agency, 1968.

From Symposium on Heavy-Water Power Reactors, Vienna, Austria. See STI/PUB-163; CONF-670917.

The operational availability record is presented, and the daily and seasonal maintenance operations are reported. Leak tightness is discussed and comments are made on the relative complexity of the system. The experience gained from using the reactor as a fuel test facility during the last two years is also reported. (auth)

30226 DOUGLAS POINT GENERATING STATION COMMISSIONING. Williams, G. H. (Ontario Hydro, Tiverton). pp 83-101 of Heavy-Water Power Reactors. Vienna, International Atomic Energy Agency, 1968.

From Symposium on Heavy-Water Power Reactors, Vienna, Austria. See STI/PUB-163; CONF-670917.

Experiences encountered at the Douglas Point Nuclear Power Station are described. Background with respect to the basic process, equipment locations, and commissioning history is given. Three commissioning philosophies followed in the commissioning of Canadian nuclear power stations are mentioned: no ordinary water used for commissioning heavy-water systems; fuelling machines used for initial fuel loading; and no portable steam-generating equipment for preliminary turbine-generator run up. Against this background the following experiences are mentioned: low power physics measurements; fuel channel replacement and faulty booster removal; heat transport pressure control; ion-exchange resin in the heat transport system; heat transport pumps; boiler level control; possible fretting of pressure tubes; turbine operation; and heavy-water experience. (auth)

30227 MARVIKEN REACTOR STATION: PRESENT STATUS AND COMMENTS ON SPECIAL DESIGN FEATURES. Nilson, R. (AB Atomenergi, Stockholm). pp 103-12 of Heavy-Water Power Reactors. Vienna, International Atomic Energy Agency, 1968.

From Symposium on Heavy-Water Power Reactors, Vienna, Austria. See STI/PUB-163; CONF-670917.

The Marviken prototype (boiling heavy-water reactor with provisions for integral nuclear superheat) is under construction and is planned to go critical at the end of 1968. The experimental programme for verification of boiling performance and for superheat technology is reviewed, including results on the major technical areas. Comments on direct-cycle turbine design and leak tightness for heavy-water circuits are made. The highlights and a summary of project experience from heavy-water reactor design and construction are given. (auth)

30228 KARACHI NUCLEAR POWER PROJECT: PROGRESSIVE CONSTRUCTION AND DESIGN FEATURES. Johnston, R. C. (Canadian General Electric Co. Ltd., Peterborough, Ont.). pp 113-23 of Heavy-Water Power Reactors. Vienna, International Atomic Energy Agency, 1968.

From Symposium on Heavy-Water Power Reactors, Vienna, Austria. See STI/PUB-163; CONF-670917.

Design features that have evolved as a result of experience gained from NPD and CANDU (Douglas Point) and current progress of design and construction are described. The use of a prestressed-concrete containment building has enabled a flexible construction schedule to be adopted for the steam-raising portion of the plant. The base slab and concrete core of the reactor will be poured separate from the walls and the dome. The major steel work and equipment will be installed under a temporary cover before the erection of the prestressed walls and dome. The use of the water shield tank simplifies installation of the calandria, alignment and commissioning of the reactor. It also speeds up the concrete shielding construction, since there are fewer cooling coils to be embedded in the concrete, improves the ion chamber housing, and simplifies the reactivity mechanism arrangement. The control system is described. It enables the control to be more fully tested and commissioned at the factory before shipment. Improved control-room design facilities shorter construction and commissioning times than has been experienced with previous stations. Current state of progress in the design and construction is described. (auth)

30229 TESTING OF THE EL4 POWER PLANT. Carle, R. (CEN, Saclay, France); Schulhof, P.; Brisset, J. C. pp 125-36 of Heavy-Water Power Reactors. Vienna, International Atomic Energy Agency, 1968. (In French).

From Symposium on Heavy-Water Power Reactors, Vienna, Austria. See STI/PUB-163; CONF-670917.

The first tests of the core channels in the EL4 power plant were performed on the various prototype channels. The results obtained on channel structure, force tubes and guide rods in particular, are described. The power plant tests began on 15 March 1966 with the start-up of the turbo-blowers of the CO_2 circuit, tested on an experimental loop. A second important series of trials was begun in November 1966; by means of electric heaters the CO_2 circuit and the reactor block were heated to 240°C (normal cold temperature of the circuit) so that the mechanical performance of these structures could be checked. The reactor began to go into power operation in May 1967 after neutron tests in the cold. The results of this operation up to September 1967 are presented. Also given are the results of tests made on the control-rod drive mechanisms, the heavy-water circuit, the filed-fuel element detection system, and the fuel handling equipment. (auth)

30230 PHYSICS PROBLEMS IN TESTING AND BRINGING EL4 INTO POWER OPERATION. Girard, Y.; Cherot, J.; Geffroy, J. (CEN, Saclay, France). pp 137-45 of Heavy-Water Power Reactors. Vienna, International Atomic Energy Agency, 1968. (In French).

From Symposium on Heavy-Water Power Reactors, Vienna, Austria. See STI/PUB-163; CONF-670917.

A brief description of the composition of the core and methods of neutron control is presented. Reactivity measurements (methods used, coefficients measured, general reactivity balance); balancing of temperatures at the channel outlets (importance of this balance, perturbation factors, results obtained); thermal conditions in channel (fuel element equipment, purpose and types of measurements, thermal loss problems); and fast shutdown (special problems connected with fast shutdown of this type of reactor, measurement of cooling by natural convection or thermosiphon, residual power measurements) are described. (auth)

30231 PROSPECTS OF HEAVY-WATER REACTOR DEVELOPMENT IN CZECHOSLOVAKIA. Hulovec, J.; Chlumsky, V.; Komarek, A. (Skoda Works, Pilsen, Czechoslovakia). pp 147-60 of Heavy-Water Power Reactors. Vienna, International Atomic Energy Agency, 1968.

From Symposium on Heavy-Water Power Reactors, Vienna, Austria. See STI/PUB-163; CONF-670917.

The advantages of the heavy-water reactor for the Czechoslovak nuclear power programme are briefly discussed. The results of comparative studies of three heavy-water reactor types of 500 MW(e) are given: gas-cooled reactor fueled with natural metallic uranium; gas-cooled reactor fueled with natural UO_2; and organic-cooled reactor fueled with natural UC (DOR). These types are evaluated from the point of view of technical parameters, utilization of accumulated technical and operational experiences, further requirements for development, and needs and possibilities of import. It is concluded that there are serious doubts about the future prospects of the DOR type under Czechoslovak conditions; future development should work towards improvement of the gas-cooled reactors. The economic realization of the gas-cooled reactor fueled with natural UO_2 currently depends on suitable fuel element cladding material which has not been developed yet. In the first stage of development it is therefore supposed to improve the reactor with metallic natural fuel. The prototype of this reactor of 150 MW(e) is under construction in Slovakia. A power reactor project of 300 MW net of the same type has been worked up. It includes a number of technical improvements leading to better economical parameters. The reactor design of 500 MW net of the same type is being worked up in two alternatives: the current concept in the steel pressure vessel, and the integral conception in the concrete pressure vessel. The comparison of technical parameters of the above-mentioned output stages is discussed. (auth)

30232 PLUTONIUM RECYCLE TEST REACTOR (PRTR): OPERATING EXPERIENCE AND SUPPORTING R AND D, ITS APPLICATION TO HEAVY-WATER POWER REACTOR DESIGN AND OPERATION. Harty, H. (Battelle Memorial Inst., Richland, Wash.). Contract AT(45-1)-1830. pp 161-81 of Heavy-Water Power Reactors. Vienna, International Atomic Energy Agency, 1968.

From Symposium on Heavy-Water Power Reactors, Vienna, Austria. See STI/PUB-163; CONF-670917.

Answers to questions about heavy-water, pressure-tube, power reactors, concerning pressure-tube serviceability, heavy-water management problems, long-term behavior of special pressure-tube reactor components, and unique operating maintenance problems are presented. (auth)

30233 CANDU-BLW-250. Pon, G. A. (Atomic Energy of Canada Ltd., Sheridan Park, Ont.). pp 201-15 of Heavy-Water Power Reactors. Vienna, International Atomic Energy Agency, 1968.

From Symposium on Heavy-Water Power Reactors, Vienna, Austria. See STI/PUB-163; CONF-670917.

The CANDU-BLW reactor utilizes a heavy-water moderator, natural uranium oxide fuel, and a boiling light-water coolant. This type of plant must have a minimum light-water inventory in the reactor core. A minimum inventory is obtained by reducing the cross-sectional area for coolant flow to a minimum, and by operating at a low coolant density. In CANDU-BLW-250, this is accomplished by operating a closed spaced fuel rod bundle at high steam quality. Design features include: heat transfer; hydrodynamic stability; control; and safety. The results of some accident analyses are presented. (auth)

30234 LARGE HEAVY-WATER POWER REACTOR WITH PRESTRESSED-CONCRETE PRESSURE VESSEL. Stueger, R. (Siemens AG, Erlangen, Ger.). pp 219-32 of Heavy-Water Power Reactors. Vienna, International Atomic Energy Agency, 1968.

From Symposium on Heavy-Water Power Reactors, Vienna, Austria. See STI/PUB-163; CONF-670917.

The concept developed by Siemens is a heavy-water moderated and cooled reactor designed to use a prestressed-concrete vessel suitable for very high coolant pressures. A further advantage is that the upper vessel cover can be removed, which previously seemed inconceivable with prestressed-concrete vessels. This

new design of pressure vessel makes it possible to arrange inside the reactor vessel all the main primary circuit components, such as the steam generator and coolant pumps. The reactor is moderated and cooled with heavy water. The main coolant is circulated by impeller pumps. An average quality of approximately 10% is achieved in the water at the cooling channel outlet. A portion of the coolant is subcooled approximately 100°C and fed as moderator to the moderator tank. The primary heavy-water cooling circuit is at an operating pressure of 100 kg/cm^2 abs. In the secondary light-water circuit live steam of ~274°C at 60 kg/cm^2 abs. is attained. The core consists of 336 cooling channels. Each channel accommodates one fuel bundle consisting of 36 uranium dioxide fuel rods. The shroud tubes are not insulated from the moderator. The reactor is designed for natural uranium. An average burnup of 8500 MWd/t U is achieved. On-load refuelling is carried out by means of an internal loading machine inside the pressure vessel. The steam generator is arranged at the periphery of the reactor core and consists of groups of many small units. Each group comprises a condenser, a subcooler and a moderator cooler section. The high-speed axial-flow pumps are placed in the bottom concrete plug. There are 36 control rods driven by an external mechanism mounted on the pressure vessel. The reference design presented refers to a plant size of 600 MW(e). (auth)

30235 DESIGN DETAILS OF THE CGE VERTICAL HEAVY-WATER PRESSURE-TYPE REACTOR: SOME FACTORS INFLUENCING THE DESIGN. Williams, N. L. (Canadian General Electric Co. Ltd., Peterborough, Ont.). pp 233-43 of Heavy-Water Power Reactors. Vienna, International Atomic Energy Agency, 1968.

From Symposium on Heavy-Water Power Reactors, Vienna, Austria. See STI/PUB-163; CONF-670917.

The vertical HWR basic design criteria were to simplify existing designs to improve reliability and availability and to do this with existing proven technology. It was also a requirement to maintain access to operating areas at all times and to provide adequate shutdown shielding of the reactor to permit contact maintenance. The simplified fuel channel characteristics are presented. The use of reactivity control mechanisms and steam by-pass to enable the power plant to operate with a continuously varying output over a wide range is described. Operation economics are presented. (auth)

30236 PERFORMANCE ASPECTS OF THE STEAM-GENERATING HEAVY-WATER REACTOR. Hicks, D. (United Kingdom Atomic Energy Authority, Winfrith, Eng.). pp 245-66 of Heavy-Water Power Reactors. Vienna, International Atomic Energy Agency, 1968.

From Symposium on Heavy-Water Power Reactors, Vienna, Austria. See STI/PUB-163; CONF-670917.

The factors influencing the performance of SGHW cores are reviewed. The combined theoretical and experimental programme undertaken to solve physics and thermal behavior problems is described. It is shown that as a result the core performance of SGHW can now be predicted to adequate design accuracy and the flexibility of the concept correspondingly exploited. (auth)

30237 MULTI-UNIT ASPECTS OF THE PICKERING GENERATING STATION. Morison, W. G. (Atomic Energy of Canada Ltd., Sheridan Park, Ont.). pp 267-84 of Heavy-Water Power Reactors. Vienna, International Atomic Energy Agency, 1968.

From Symposium on Heavy-Water Power Reactors, Vienna, Austria. See STI/PUB-163; CONF-670917.

The Pickering nuclear power station has been planned and laid out on an eight-unit station, four units of which have now been authorized for construction. Each of these four units consists of a single heavy-water moderated and cooled CANDU-type reactor and auxiliaries coupled to a single tandem compound turbine generator with a net output of approximately 500 MW(e). The units are identical and are scheduled to come into operation at intervals of one year from 1970 to 1973. The station has been planned with central facilities for: administration maintenance laboratories, stores, change rooms, decontamination and waste management services. A common control center, cooling water intake and discharge system, and spent fuel storage bay for four units has been arranged. A feature of the multi-unit station is a common containment system. Cost savings in building a number of identical units on the same site result from a single exclusion area, shared engineering costs, equipment purchase contracts for four identical components, and efficient use of construction plant. Operating cost savings are anticipated in the use of a common operating and maintenance staff and spare parts inventory. The plant has been arranged to minimize problems of operating, commissioning and constructing units at the same time on the same site. The layout and construction sequence have been arranged so that the first unit can be commissioned and operated with little or no interference from the construction forces working on succeeding units. (auth)

30238 DESIGN OF Pu SELF-SUSTAINING REACTOR WITH D_2O MODERATOR AND BOILING H_2O COOLANT. Sawai, S.; Yasukawa, S.; Shinoda, W. (Japan Atomic Energy Research Inst., Tokyo). pp 285-98 of Heavy-Water Power Reactors. Vienna, International Atomic Energy Agency, 1968.

From Symposium on Heavy-Water Power Reactors, Vienna, Austria. See STI/PUB-163; CONF-670917.

The results obtained from the investigations and designs for a heavy water-moderated and light water-cooled reactor are presented. The study and investigation based on the principle of using natural uranium led to the adoption of a Pu self-sustaining cycle, from the standpoint of fuel-cycle cost and power cost. This cycle has the following advantages: it is equivalent to a slightly enriched fuel cycle giving much flexibility in the core design, and about 15,000 MWd/t of burnup might be expected with natural uranium when enriched by Pu produced in its own spent fuel. The positive void coefficient, which decreases the stability and safety of this reactor type, would no longer be a major problem when using Pu enrichment. However, it must be noted that a slightly enriched uranium would be loaded in the initial cycle, which might have a positive void coefficient. The problem can be partially overcome by placing inter-lattice tubes in the core as in the SGHW in order to adjust the moderator to fuel ratio, making a lower ratio for the U-loaded core and a higher ratio for the Pu-loaded core. This would give rise to a higher quality of reactor exit steam or higher dryout limit in the Pu-loaded than in the U-loaded core. On-power refuelling is one of the major problems to be solved for the reactor. Two refuelling methods (access from the reactor top and from the reactor bottom) were investigated and the corresponding refuelling machines were designed. An outline of some reshuffling schemes, stability and safety analysis and plant design (stressed to the reactor structure) are also given. (auth)

30239 STEAM SUPERHEATING IN BHWRs USING PLUTONIUM ENRICHMENT. Strugar, P.; Raisic, N.; Studovic, M.; Bosevski, T.; Afgan, N.; Zaric, S. (Boris Kidric Inst. of Nuclear Sciences, Belgrade). pp 299-308 of Heavy-Water Power Reactors. Vienna, International Atomic Energy Agency, 1968.

From Symposium on Heavy-Water Power Reactors, Vienna, Austria. See STI/PUB-163; CONF-670917.

The Swedish version of the natural uranium BHWR, which is considered a potential type for the first Yugoslav nuclear power plant, is taken as a base for the analyses of the introduction of steam superheating, when the superheat fuel elements are enriched by plutonium produced in the boiling part of the reactor. The optimization of the reactor is made for Yugoslav conditions accepting the participation of the local industry in production of some reactor components. The geometrical, physical, thermal and hydraulic parameters of the boiling and superheat zones of the reactor are determined under the condition that all produced plutonium is used. The necessary criteria for the safe operation of the equipment are satisfied. The effect of the use of plutonium enrichment on the unit energy costs is evaluated and comparison is made with the unit energy costs in the standard BHWR. A critical analysis is made of the advantages and disadvantages related to technology, safety and economics, when the boiling heavy-water reactor with natural uranium is adapted for steam superheating. (auth)

30240 ADAPTATION OF THE DESIGN OF HEAVY-WATER POWER REACTORS TO THE REQUIREMENTS OF DUAL-PURPOSE PLANTS. Aschner, F. S.; Yiftah, S.; Glueckstern, P. (Technion-Israel Inst. of Tech., Haifa). pp 309-30 of Heavy-Water Power Reactors. Vienna, International Atomic Energy Agency, 1968.

From Symposium on Heavy-Water Power Reactors, Vienna, Austria. See STI/PUB-163; CONF-670917.

Heavy-water dual-purpose and single-purpose (water only) reactors are investigated. The basic designs of the dual-purpose reactors have been assumed similar to the design of the Canadian (HWN) and French EL4 (HWGCR) power reactors. Typical design data for a 200-MW(e) net HWN dual-purpose reactor optimized for a given set of economic parameters (fixed charges–7%, plant factor–85%, electricity value–5.3 mill/kWh) are described. The results show that water production is increased by approximately 10% and a substantial water cost reduction is obtained. For a 200-MW(e) net HWN dual-purpose plant the water cost reduction at 7% fixed charge rate amounts to approximately 5%. The possible use of low-temperature gas taken from the gas outlet of the main steam generator of an HWGCR reactor to produce a low-pressure process steam has been investigated. Combined utilization of

moderator heat and low-temperature gas may be considered in a dual-purpose back-pressure or condensing power plant. Due to the fact that in back-pressure dual-purpose plants energy is not wasted in condenser cooling water as in plants for power only, and due to the interdependence of fuel burnup and thermal efficiency, steam cycle and core design data are different. A comparison with other dual-purpose reactor types (PWR, BWR, AGR), and with fuel-oil fired plants is also made. Performance (steam conditions, auxiliary power, water/electricity ratio), investments, steam and water costs are compared. At 7% fixed charges the results show that up to approximately 240 MW(e) net lowest water cost from dual-purpose plants are obtained from plants using HWN reactors. The relative influence of the various reactor design parameters has been determined by running the computer codes with varied values of the design parameters in the vicinity of the optimum. Typical effects on various design features and process steam cost and the effect of economic parameters on optimum design are analyzed. Potential cost reductions due to less conservative design, technological developments and possible future material and equipment price reduction have been analyzed for HWN dual-purpose plants. The analysis shows that substantial cost savings could be obtained if predicted technological developments and price reductions will be realized. (auth)

30241 RESEARCH ON HEAVY-WATER REACTORS WITH CO_2 COOLANT. Fonteray, J.; Martin, R.; Ringot, C.; Roche, R. (CEN, Saclay, France). pp 331-43 of Heavy-Water Power Reactors. Vienna, International Atomic Energy Agency, 1968. (In French).

From Symposium on Heavy-Water Power Reactors, Vienna, Austria. See STI/PUB-163; CONF-670917.

The first French heavy-water power plant EL4 is cooled by CO_2 under pressure. During construction of the EL4, study of a 600 MW(e) reactor of similar design was made. Under a co-operation agreement with the Siemens and Sulzer Companies, the CEA has been conducting a study for a year now on a power station with gas cooling and contained a prestressed concrete vessel. A more compact design can be obtained by integration. Equilibration of pressures between the heavy-water and the carbon dioxide permits better neutron economy, the force tube maintaining the gas pressure being replaced by a single calandria tube. The safety of the facility is also improved provided that the various ducts running through the vessel are suitably designed. The main technical problems relate to: equilibration of pressures (several designs for reducing diffusion of gas into the water are investigated); the handling device which is incorporated into the upper part of the vessel and which must work in an atmosphere of dry CO_2; and the exchangers, which must be set up in such a way that a faulty pipe can be detected and isolated, and even the whole set replaced. To derive the greatest advantage from the favorable neutron characteristics of heavy-water reactors, a low-absorption canning material with a high resistance to corrosion and good mechanical strength at a temperature of about 660°C must be developed. The work done on beryllium has enabled its ductility to be considerably improved, but the problem of post-irradiation embrittlement, due to accumulation of helium atoms at the grain boundaries, has still not been overcome. The alloy zirconium–copper (1.6% or 2.5% Cu) should provide a suitable canning material. Irradiation results obtained in the reactor PEGASE, under more stringent conditions than those obtaining in a standard reactor, are encouraging enough for it now to be proposed that the stainless-steel cladding in EL4 should be gradually replaced by zirconium–copper cladding, which would enable the reactor to operate under the proposed conditions of temperature and specific capacity. (auth)

30242 HEAVY-WATER POWER REACTORS IN INDIA: REVIEW OF RESEARCH AND DEVELOPMENT PROGRAMME. Meckoni, V. N. (Bhabha Atomic Research Centre, Bombay). pp 347-52 of Heavy-Water Power Reactors. Vienna, International Atomic Energy Agency, 1968.

From Symposium on Heavy-Water Power Reactors, Vienna, Austria. See STI/PUB-163; CONF-670917.

Heavy-water reactors would be most suitable for Indian conditions. The present research and development efforts include fuel cycle studies on the use of plutonium/thorium and ^{233}U/thorium fuel cycles in pressurized heavy-water cooled as well as in boiling light-water cooled, heavy-water moderated reactors; use of zero-energy Zerlina reactor for critical experiments and for study of intra-cell properties of multi-rod fuel clusters; and engineering studies related to the use of boiling light water as coolant. Development efforts are also being made towards the production of special reactor materials such as ceramic fuel, heavy water and Zircaloy, and manufacture of control instrumentation and specialized reactor components. (auth)

30243 PROJECT FOR AN ADVANCED THERMAL REACTOR IN JAPAN. Aoki, S. (Tokyo Inst. of Tech.). pp 353-9 of Heavy-Water Power Reactors. Vienna, International Atomic Energy Agency, 1968.

From Symposium on Heavy-Water Power Reactors, Vienna, Austria. See STI/PUB-163; CONF-670917.

Since the heavy-water-moderated boiling light-water-cooled reactors are already being constructed or designed as SGHWR and CANDU–BLW, the Japanese project also falls into the same category, although there are a few distinguishing features. The initially loaded fuel is made of slightly enriched uranium, similar to that in SGHWR. After the second fuel cycle, natural uranium mixed with the plutonium produced in the ATR prototype will be loaded to test whether the plutonium self-sustaining fuel cycle system can increase the attainable burnup significantly. The prototype reactor will have an output of about 200 MW(e) and a core height of about 4 m, which is similar to that of commercial-scale reactors today. The primary conceptual designs have already been carried out by several Japanese firms from summer 1966 to March 1967. The results are now being evaluated for the prototype reactor to fix the specifications for the more detailed design to follow. The fundamental and developmental studies on, for example, heat transfer and fluid dynamics have been carried out not only by the Japan Atomic Energy Research Institute but also by industry and other organizations. However, the available facilities are insufficient for the project and therefore the construction of large experimental facilities such as critical assembly and boiling heat-transfer loop to test full-scale fuel assembly are now being undertaken. (auth)

30244 UNITED STATES HWOCR PROGRAMME: RESULTS AND CONCLUSIONS. Storrs, C. L. (Combustion Engineering Inc., Windsor, Conn); Trilling, C. A. pp 361-81 of Heavy-Water Power Reactors. Vienna, International Atomic Energy Agency, 1968.

From Symposium on Heavy-Water Power Reactors, Vienna, Austria. See STI/PUB-163; CONF-670917.

The objective of the US HWOCR programme was the development of a reactor which would conserve resources of fissile material while generating energy at competitive cost in the near future. Long-range application of the concept was expected because of its ability to produce plutonium for fast breeder inventory and because of features which simplified extrapolation to very large sizes, with attendant cost reductions. Design studies showed that a 1000-MW(e) size energy generation costs would be approx. 0.5 mill/kWh less for an HWOCR than for current US reactor types. The programme emphasized extensive component development and testing to provide maximum assurance of technical success. Irradiation of a string of SAP-clad UC fuel rod assemblies was carried out in the NRU reactor in Canada to a burnup of 10,000 MWd/MtU and confirmed the design assumptions of the behavior of the fuel. Two additional fuel strings now under irradiation were approaching burnups of 12,000 and 8000 MWt/MtU as of May 1967. The organic coolant performance in the fuel irradiation tests showed that the purity control methods and criteria used were adequate to maintain satisfactory control of film deposition from the point of view of both cladding temperature and fuel assembly pressure drop. Out-of-pile hydraulic tests of fuel assemblies confirmed design pressure drop values and demonstrated considerably better coolant mixing in the fuel subchannels than required by the reference designs. A process for the fabrication of SAP billets for both cladding and pressure tubes was developed on a laboratory scale at Oak Ridge National Laboratory. Full-scale SAP pressure tubes were extruded and tested in an out-of-pile organic facility. These tests showed evidence of wear on the pressure tube as a result of contract with the SAP cladding fins of mock-up fuel assemblies. A satisfactory solution to this problem still remains to be developed. Both rolling and hot-pressing were established as satisfactory techniques for the joining of the SAP pressure tubes to the out-of-core steel pressure tube extensions. A conceptual design of the on-power refuelling system was completed and testing of some critical components carried out. Some aspects of the interface between the fuel assemblies and the fuel handling machine have not been resolved. Satisfactory progress was achieved in the development and testing of a shutdown control rod system. Severe requirements for high reliability of the HWOCR control system were established to assure reliable control of a plant with positive coolant temperature and void coefficients. The HWOCR programme was determined in March 1967 (with the fuel irradiations continuing under AECL direction), leaving some of its uncertainties unresolved, but having provided a solid technical foundation for the concept. (auth)

30245 PRESENT OUTLOOK OF THE UNITED STATES HEAVY-WATER REACTOR PROGRAMME. Tardiff, A. N.

(Atomic Energy Commission, Washington, D. C.). pp 399-407 of Heavy-Water Power Reactors. Vienna, International Atomic Energy Agency, 1968.

From Symposium on Heavy-Water Power Reactors, Vienna, Austria. See STI/PUB-163; CONF-670917.

The heavy-water reactor program in the United States is described. The applications of dual-purpose and desalting heavy-water-moderated water-cooled systems are described. (auth)

30246 PERFORMANCE OF THORIUM ORGEL REACTOR. Lafontaine, F.; Rinaldini, G.; Zanantoni, C. (EURATOM-CCR, Ispra, Italy). pp 409-28 of Heavy-Water Power Reactors. Vienna, International Atomic Energy Agency, 1968. (In Italian).

From Symposium on Heavy-Water Power Reactors, Vienna, Austria. See STI/PUB-163; CONF-670917.

The general characteristics of a thorium ORGEL reactor are presented. The criteria governing the choice of fuel element are reviewed, and an element consisting of a cluster of 37 SAP-clad ThO_2 rods is chosen. The technical and economic performance of the fuel cycle, investment in fissionable material, specific consumption, cost of the cycle, is analyzed as a function of various parameters such as lattice pitch, power density and burn-up. For every case considered the uranium is entirely recycled; the supplementary fissionable material is uranium-235. The performance is compared with that obtained in a uranium reactor, and an analysis is made of the economic conditions under which the thorium cycle would become more advantageous than the uranium. (auth)

30247 THORIUM-FUELLED HEAVY-WATER-MODERATED ORGANIC-COOLED REACTORS. Croft, M. W.; Webb, R. A. (Babcock and Wilcox Co., Lynchburg, Va.). pp 429-41 of Heavy-Water Power Reactors. Vienna, International Atomic Energy Agency, 1968.

From Symposium on Heavy-Water Power Reactors, Vienna, Austria. See STI/PUB-163; CONF-670917.

The performance of thorium fuel cycles in the HWOCR is evaluated and several 1000 MW(e) conceptual designs are developed for a thorium-fuelled HWOCR. The work is conducted in parallel with a much larger design and development effort on the uranium-fuelled concept and is restricted primarily to thorium recycle and core design aspects. The thorium fuel-cycle studies are performed to develop economical, heavy-water reactors with optimum fuel utilization characteristics. Three reference conceptual designs utilizing the three different fuel elements are completed and are based on extensive parameter studies and recycle considerations; the economics and fuel utilization of each design are evaluated, and technical feasibility, development costs, and compatibility with a uranium-optimized HWOCR are considered. (auth)

30248 PROGRESS IN THE DEVELOPMENT OF A HEAVY-WATER MODERATED AND COOLED THORIUM-^{233}U CONVERTER. Steinert, C. (Siemens AG, Erlangen, Ger.). pp 443-50 of Heavy-Water Power Reactors. Vienna, International Atomic Energy Agency, 1968.

From Symposium on Heavy-Water Power Reactors, Vienna, Austria. See STI/PUB-163; CONF-670917.

Prominence is being given to a pressure-vessel reactor moderated and cooled by heavy water. Contrary to natural uranium types the thorium reactor will have a quasi-homogeneous core structure and a much lower heavy-water content and therefore will be in appearance more similar to a light-water reactor. With a quasi-homogeneous lattice and the fact that flux peaks are more easily avoided in a D_2O core than in an H_2O one, the mean specific fuel power (which is decisive for the economic efficiency of a thorium reactor) attains a higher value than in reactors with clustered fuel elements or in light-water reactors. The D_2O–thorium reactor will have core power densities in the range of those attained in boiling light-water reactors. This power density is greater than in any other advanced converter. At minimum fuel cycle costs in the range of 1 mill/kWh, including costs for D_2O inventory, the specific consumption of ^{235}U for maintaining a reprocessed equilibrium cycle is calculated to be 0.20 g ^{235}U/MWd, including diffusion tails. Calculation methods are shown to be in good agreement with lattice experiments. On account of the similarity of core design and power density with those of light-water reactors, development of the heavy-water thorium converter is directly linked with the development of light-water uranium converters. Similar prospects of a reliable nuclear power production but with better utilization of the natural fissile resources can therefore be anticipated for a heavy-water thorium reactor. (auth)

30249 PRELIMINARY ASSESSMENT OF HEAVY-WATER THORIUM REACTORS IN THE BRAZILIAN NUCLEAR PROGRAMME. De Salvo Brito, S.; Lepecki, W. P. S. (Instituto de Pesquisas Radioativas, Belo Horizonte, Brazil). pp 451-66 of Heavy-Water Power Reactors. Vienna, International Atomic Energy Agency, 1968.

From Symposium on Heavy-Water Power Reactors, Vienna, Austria. See STI/PUB-163; CONF-670917.

A reference conceptual design of a heavy-water-cooled and -moderated thorium converter reactor has been developed. The main features of that concept are the use of a prestressed-concrete pressure vessel, integrated arrangement of the primary circuit and the possibility of on-load fuel management. Economic competitiveness could be the result of high compactness, low capital costs and low fuel consumption. The technology involved is not very sophisticated; intensive engineering development work must be done in areas like fuel charge machine, concrete vessel insulation, and proper design of heat exchangers, but these problems could be solved without seriously compromising the economic feasibility of the concept. Preliminary studies were made on the alternative use of enriched uranium or plutonium as a feed for the programme; in the latter case, plutonium could be produced in natural uranium reactors of the same type. The general conditions favoring each of these approaches to the thorium cycle have been determined, in particular those related to the costs of the fissile materials in the world market and to the country's policy related to nuclear fuel imports. The results of the preliminary studies are presented. (auth)

30250 COSTS AND ECONOMICS OF HEAVY-WATER-MODERATED NUCLEAR PLANTS. Haywood, L. R.; Aikin, A. M. (Atomic Energy of Canada Ltd., Chalk River, Ont.). pp 469-80 of Heavy-Water Power Reactors. Vienna, International Atomic Energy Agency, 1968.

From Symposium on Heavy-Water Power Reactors, Vienna, Austria. See STI/PUB-163; CONF-670917.

The development of heavy-water-moderated power reactors in Canada has included studies of three coolant systems: heavy water, light water, and organic. Economic comparisons do not show large advantages of one system over the other, but each offers its own technical and operational advantage. As the heavy-water-cooled concept is the most advanced technically, with plants in operation, this system is used to show details of capital, fuel and operating costs. That such a system is economically competitive in the world market was shown recently in the bids for a reactor in Finland. The economic advantages and disadvantages of the alternate cooling systems are discussed. (auth)

30251 GENERAL POSITION OF HEAVY-WATER REACTORS. Naudet, R. (CEN, Saclay, France). pp 481-90 of Heavy-Water Power Reactors. Vienna, International Atomic Energy Agency, 1968. (In French).

From Symposium on Heavy-Water Power Reactors, Vienna, Austria. See STI/PUB-163; CONF-670917.

Improvements in heavy water-reactors are described. The mere fact that commercial nuclear power stations are now well established should make the development of the economic potential of these reactors worthwhile. The main point, however, is that present conditions will certainly change. The importance of the initial capital investment in fissile materials and its speculative character is stressed. The place of heavy-water reactors in relation to the conditions existing in France is described. (auth)

30252 HEAVY-WATER REACTORS: THEIR ROLE IN THE UTILIZATION OF LONG-TERM FUEL RESOURCES. Margen, P. H. (AB Atomenergi, Stockholm). pp 491-509 of Heavy-Water Power Reactors. Vienna, International Atomic Energy Agency, 1968.

From Symposium on Heavy-Water Power Reactors, Vienna, Austria. See STI/PUB-163; CONF-670917.

The merits of various composite reactor strategies, including several variants based entirely or partially on heavy-water reactors (HWRs) are discussed. The present worth of future integrated uranium costs for various strategies is also discussed. This provides strong financial incentives for the continued development of HWRs additional to the incentives arising from the improvement in HWR economics with a projected rise in unit sizes. Brief mention is made of the influence of the strategies on diffusion plant capacity requirements. (auth)

30253 SIGNIFICANCE OF THE HEAVY-WATER REACTOR IN AN ENRICHED-URANIUM NUCLEAR POWER ECONOMY. Dietrich, J. R. (Combustion Engineering Inc., Windsor, Conn.). Contract AT(38-1)-430. pp 511-28 of Heavy-Water Power Reactors. Vienna, International Atomic Energy Agency, 1968.

From Symposium on Heavy-Water Power Reactors, Vienna, Austria. See STI/PUB-163; CONF-670917.

The superior neutron economy of the heavy-water reactor offers substantial improvements over the light-water reactor in the quantity of useful energy produced per ton of nuclear fuel mined. These improvements, which can be counted on for im-

portant extensions of the effective nuclear fuel resource in the event that the development of the fast breeder is slow, may be realized to different degrees by different fuel cycle routes. If fast breeders are developed as anticipated, the natural-uranium heavy-water reactor can fill the complementary role as an efficient producer of low-cost plutonium for the initial inventory of the breeders. These possibilities, in the United States, are contingent upon the development of a heavy-water reactor capable of competing economically with the light-water reactors. Although rising uranium prices may favor heavy water, early success is believed to require development which is directly responsive to the distinguishing characteristics of the US economy: high capital charge rates. (auth)

30254 OUTLOOK FOR HEAVY-WATER REACTORS. Lewis, W. B. (Atomic Energy of Canada Ltd., Chalk River, Ont.). pp 545-61 of Heavy-Water Power Reactors. Vienna, International Atomic Energy Agency, 1968.

From Symposium on Heavy-Water Power Reactors, Vienna, Austria. See STI/PUB-163; CONF-670917.

Details are given of several fuel cycle changes showing the inventories of fuel and heavy water involved in meeting market changes and the expectation of net fuel cycle costs being held in the range of 0.3 to 0.6 mill/kWh in terms of today's dollar values despite a rise in the cost of uranium. The analysis shows possible interaction with other types of reactors including breeders. Reasons are given for welcoming any possible future competition or partnership from these types in meeting the growing world demand for harnessed energy. (auth)

30255 COMPARATIVE EVALUATION OF THE PERFORMANCE AND ECONOMICS OF HEAVY-WATER-MODERATED REACTORS. Lane, J. A.; Cheverton, R. D.; Kasten, P. R. (Oak Ridge National Lab., Tenn.). pp 563-81 of Heavy-Water Power Reactors. Vienna, International Atomic Energy Agency, 1968.

From Symposium on Heavy-Water Power Reactors, Vienna, Austria. See STI/PUB-163; CONF-670917.

The results of a technical and economic evaluation of 1000-MW(e) heavy-water-moderated reactors performed by the Oak Ridge National Laboratory as part of the overall evaluation of civilian power reactors are presented. Designs considered include slightly enriched UC, natural UC and U metal fuelled heavy-water-organic-cooled reactors developed jointly by Atomics International and Combustion Engineering; thorium oxide and thorium metal fuelled HWOCRs developed by Babcock and Wilcox; and a heavy-water-boiling, light-water-cooled reactor developed by Atomic Energy of Canada Ltd and Sargent and Lundy. Power production costs associated with each design were obtained from detailed estimates of capital costs, operating and maintenance costs and fuel cycle costs. Both current and future trends in costs were derived. For the technological evaluation, it was considered that the reactor design in each case must be feasible but may involve engineering development. Required research and development programmes are identified along with associated costs and time-tables for achieving commercially competitive 1000-MW(e) plants. These costs may be compared with power costs of light-water reactors which appear to be in the range of 4.0 to 4.2 mills/kWh for the assumed economic conditions. Thus the uranium fuelled heavy-water reactors may have a slight economic advantage over light-water converters. The heavy-water-moderated reactor designs considered, moreover, were found to yield more plutonium per year and this may be an important advantage for the future U. S. power system, and other power systems. (auth)

30256 PHYSICS DESIGN ASPECTS OF THE MARVIKEN REACTOR. Norinder, O. (AB Atomenergi, Stockholm). pp 585-96 of Heavy-Water Power Reactors. Vienna, International Atomic Energy Agency, 1968.

From Symposium on Heavy-Water Power Reactors, Vienna, Austria. See STI/PUB-163; CONF-670917

A physical description of the reactor core is given with an updated list of the main reactor physics and related data. A survey is given of the reactor physics calculation methods: the two-group and the new multigroup lattice method for heterogeneous reactor calculations. The calculation method and the kinetic properties for the Marviken reactor are described. Experimental reactor physics and its use for establishing calculational procedures are given. Properties regarding control behavior and spatial stability are described as well as new methods for investigating spatial oscillations. Particular aspects of reactor operation with nuclear superheat are discussed. (auth)

30257 PHYSICS AND DYNAMICS OF BHWRs BASED ON EXPERIENCE WITH THE HALDEN BOILING WATER REACTOR. Lunde, J. E.; Olsen, H. Smidt (Institutt for Atomenergie, Halden, Norway). pp 597-625 of Heavy-Water Power Reactors. Vienna, International Atomic Energy Agency, 1968.

From Symposium on Heavy-Water Power Reactors, Vienna, Austria. See STI/PUB-163; CONF-670917.

Extensive reactor statics and dynamics investigations have been conducted at the Halden Boiling Water Reactor (HBWR) during the last eight years. The results obtained in particular from the operation with the second fuel charge, which is a Zircaloy-clad, 1.5% enriched uranium oxide charge, have been of considerable value for testing the validity of reactor statics and dynamics calculational models that can be used for design of reactors of the boiling heavy-water type. The initial physics experiments with this charge included measurements of buckling, critical size versus temperature, temperature reactivity coefficients, power void reactivity, zenon, control-rod reactivity worth and flux distribution. These experiments were generally compared with standard two-group calculational methods. An extensive series of experiments was conducted to investigate the dynamic behavior of the system. A theoretical model was developed to interpret the measurements. An essential feature of the model was the inclusion of a one-dimensional description of the moderator dynamics. Good agreement was found between experiments and theory. Application of the model pointed to the importance of moderator and channel sub-cooling in improving the stability characteristics of heavy-water boiling reactors. Measurements of natural circulation channel hydrodynamics behavior were further conducted, both in-pile and in a boiling loop. Comparison with existing theoretical models showed that predictions of the channel power stability limit can usually not be made better than to about ±20%. Certain dynamics experiments on the heat removal circuits of HBWR were made, and the results compared with calculations with a simplified model of these circuits. Reasonable agreement was found when care was taken to include steel and coolant capacities properly. (28 references included.) (auth)

30258 OPTIMIZATION OF BHWRs: DESCRIPTION OF PROGRAMMES AND APPLICATIONS. Haga, I. (AB Atomenergi, Stockholm). pp 627-41 of Heavy-Water Power Reactors. Vienna, International Atomic Energy Agency, 1968.

From Symposium on Heavy-Water Power Reactors, Vienna, Austria. See STI/PUB-163; CONF-670917.

Optimization programs developed for boiling heavy-water reactors of the pressure-vessel type are presented. The programs include several versions applicable to a direct or indirect steam cycle and forced or natural circulation in the core. Each program consists of 15 to 18 independent variables and a number of physical limitations to give conditions acceptable from the aspect of fuel center-line melting, burn-out, stability, etc. The main purpose of the programs has been to develop a method for rapid assessment of the influence of various assumptions on the optimum lay-out of a BHWR. The results of the optimization also establish a starting point for more detailed design studies. A brief description of the various parts of the programs together with the applied minimization method is given. A complete optimization takes 10 to 20 min on an IBM-7044 computer. The programs have been used in a number of special investigations such as the determination of the influence of the price of Pu on the optimum burnup, the comparison of direct and indirect cycle characteristics, etc. Examples of the results of some of these investigations are discussed. (auth)

30259 FUEL MANAGEMENT IN STEAM-GENERATING HEAVY-WATER REACTORS. Hicks, D. (United Kingdom Atomic Energy Authority, Winfrith, Eng.); O'Dell, F. P. pp 681-95 of Heavy-Water Power Reactors. Vienna, International Atomic Energy Agency, 1968. (AEEW-R-545).

From Symposium on Heavy-Water Power Reactors, Vienna, Austria. See STI/PUB-163; CONF-670917.

The potentially good neutron economy of the SGHW reactor and the relatively easy refuelling access permitted by pressure-tube construction lead to a wide variety of possible fuel-management schemes. The studies of possible fuel-management schemes are described. The factors influencing the choice of fuel-management scheme are reviewed briefly. (auth)

30260 COMPENSATION OF LOW BURNUP LIMITS OF METALLIC URANIUM IN HEAVY-WATER REACTORS BY ADJUSTING THE REFUELLING SCHEME. Pop-Jordanov, J.; Spasojevic, D.; Bosevski, T.; Raisic, N.; Strugar, P.; Afgan, N. (Boris Kidric Inst. of Nuclear Sciences, Belgrade). pp 697-704 of Heavy-Water Power Reactors. Vienna, International Atomic Energy Agency, 1968.

From Symposium on Heavy-Water Power Reactors, Vienna, Austria. See STI/PUB-163; CONF-670917.

An analysis is made of the possible compensation of burnup disadvantages of metallic uranium by selection of appropriate refueling scheme which for the technologically feasible burnup improves the flux form factors and allows a higher power rating. By selecting adequate axial reflectors and a larger flux-flattened zone in the radial direction, a higher power rating is obtained with a simpler

refueling scheme and a reduction in fuel inventory. Evaluations of PHWR and BHWR are made in this respect. Conclusions are drawn regarding the size and the total power of the plant with particular reference to the size and construction optimized by Yugoslav conditions. (auth)

30261 PLUTONIUM PRODUCTION AND RECYCLE IN HEAVY-WATER REACTORS. Duret, M. F. (Atomic Energy of Canada Ltd., Chalk River, Ont.). pp 705-24 of Heavy-Water Power Reactors. Vienna, International Atomic Energy Agency, 1968.

From Symposium on Heavy-Water Power Reactors, Vienna, Austria. See STI/PUB-163; CONF-670917.

Measurements of content and isotopic composition of fuel discharged from heavy-water-moderated reactors are presented. Comparisons of fuel composition measurements with calculations are reported for a fuel bundle with an irradiation of 5500 MWd/t. Similar results are described for a 19-element UO_2 bundle irradiated in the NPD reactor to about 9700 MWd/t. To assess the effect on both the capital cost and fuel cost of a 500-MW BLW moderated with heavy water and cooled with boiling light water, exploratory calculations are being made. The plutonium fuel is assumed to be produced in a heavy-water-moderated reactor of the Pickering type with a fuel burnup of 9,000 MWd/t. This corresponds to a plutonium composition of ^{239}Pu: ^{240}Pu: ^{241}Pu: ^{242}Pu: 0.62: 0.295: 0.0625: 0.022. For these initial calculations, the plutonium is uniformly mixed with uranium in the form of PuO_2 in UO_2. These survey calculations investigate changes in a variety of reactor and plant parameters such as lattice pitch, coolant pressure, etc. Large fuel channels containing large amounts of light water will tend to produce a large positive void coefficient. The value of the void coefficient is calculated. Variations in plutonium concentration are considered since if the use of plutonium is economically advantageous, it will affect the overall power system by indicating the best division of power generation between CANDU-PHW's and BLW's. The performance is compared with a natural uranium BLW. This procedure minimizes uncertainties in the estimates of capital costs for the two systems. (auth)

30262 VITROCERAMIC NUCLEAR FUEL FOR GAS-COOLED HEAVY-WATER REACTORS. Lungu, S. (Inst. of Atomic Physics, Bucharest). pp 727-36 of Heavy-Water Power Reactors. Vienna, International Atomic Energy Agency, 1968.

From Symposium on Heavy-Water Power Reactors, Vienna, Austria. See STI/PUB-163; CONF-670917.

The new nuclear fuel described is a UO_2–SiO_2 vitroceramic, which is a two-phase ceramic prepared by partial crystallization of a homogeneous melt. The phasic components are crystalline uranium dioxide and silicon dioxide rich (>99% SiO_2) glass. The properties of this material are presented. A particular fuel element shape is presented to demonstrate the suitability of vitroceramic as a fuel for natural uranium, high-temperature gas-cooled reactors. The fuel element consists of a single cylindrical rod with longitudinal holes for cooling, bearing a resemblance to the inverted-type fuel elements. The neutron balance and the fuel rating are evaluated using as a reference the EL-5 (beryllium canned) project data, but taking into consideration higher temperatures for cooling gas (carbon dioxide). These evaluations indicate both high burnup (~9500 MWd/t) and rating (over 8 MW(e)/t). (auth)

30263 ENGINEERING AND PERFORMANCE OF CANADA'S UO_2 FUEL ASSEMBLIES FOR HEAVY-WATER POWER REACTORS. Page, R. D. (Atomic Energy of Canada Ltd., Chalk River, Ont.). pp 749-71 of Heavy-Water Power Reactors. Vienna, International Atomic Energy Agency, 1968.

From Symposium on Heavy-Water Power Reactors, Vienna, Austria. See STI/PUB-163; CONF-670917.

Improvements made in design of Zircaloy-2 UO_2 fuel for the Canadian power reactors are presented. A replacement 82.5-mm-diameter 19-element bundle ($\int\lambda d\theta$ 40 W/cm) for the Douglas Point reactor has been developed using a brazed split spacer design, instead of wire-wrap, thus preventing inter-element fretting of the sheath. Both wire-wrapped and brazed split spacer bundles have reached burnups in the range of 10,000 to 20,000 MWd/t U at heat ratings $\int\lambda d\theta$ 15 to 35 W/cm, with a maximum exposure of 1200 coolant days without failures in the NPD reactor. A 103.4-mm-diameter 28-element bundle ($\int\lambda d\theta$ 42 W/cm) has been developed for the 500 MW(e) Pickering Station. Fission gas measurements have indicated a percentage release of less than 5% at $\int\lambda d\theta$ 35 W/cm to 20% at $\int\lambda d\theta$ 50 W/cm. The percentage release decreases with increased density in the range 10.3 to 10.7 and is independent of burnup up to 8000 MWd/t U. Deuterium pickup in operating Zircaloy-2 cladding, exposed to greater than 600 coolant days, has been low. For the Gentilly 250-MW(e) BLW, a fuel bundle ($\int\lambda d\theta$ 48 W/cm) has been developed to operate at 16% and greater exit steam qualitites. Fuel bundles are being tested in the range 40 to 60 W/cm. A cold void volume has been designed into the elements by means of hollow end caps to avoid internal gas pressure exceeding coolant pressure. In-reactor heat transfer tests up to 45% exit quality have shown that the fuel will have a critical power ratio of 1.5. Fuel has been operated at 50% greater than critical power for three hours without significant deterioration of the sheath. Endurance tests on fuel bundles under single-phase coolant conditions, and velocities up to 8.8 m/s, have shown that fretting is within acceptable limits. No fretting has been observed with in-pile fuel bundle tests under two-phase coolant conditions at mass velocities up to 440 g/cm^2 per s. Future programs for the BLW and PHW reactors will be to increase the fuel rating and the fissile material density. Operation of the BLW fuel elements at high (500°C) surface temperatures will be attempted. In the longer term, both plutonium and thorium containing fuels will be investigated. (auth)

30264 FACTORS AFFECTING THE DESIGN OF RODDED UO_2 FUEL BUNDLES FOR HIGH POWER OUTPUTS. Notley, M. J. F.; Lane, A. D. (Chalk River Nuclear Labs., Ont.). pp 773-90 of Heavy-Water Power Reactors. Vienna, International Atomic Energy Agency, 1968.

From Symposium on Heavy-Water Power Reactors, Vienna, Austria. See STI/PUB-163; CONF-670917.

The economic advantage of increasing power density in nuclear fuels is accepted as being very substantial. Technical limitations to fuel operation, consequential relations between parameters, and economic analysis of rod bundle designs are presented. Bundle power output is limited by the heat that can be removed by the coolant, because of approach to a critical heat flux condition, limitations imposed by coolant temperatures, or the onset of bulk boiling. These conditions are affected by the degree of subdivision of the bundle, the coolant flow rate and the mixing characteristics between bundle subchannels. Higher bundle power outputs can generally be obtained by more extensive subdivision of the fuel and higher flows, but problems of vibration, fretting and pressure drop may become more acute. Also, subdivision incurs greater fabrication costs and loss of reactivity. 19 references included. (auth)

30265 FUEL ELEMENT EXPERIENCE AT THE HALDEN BOILING WATER REACTOR. Aas, S. (OECD Halden Reactor Project, Norway); Videm, K.; Hanevik, A. pp 791-806 of Heavy-Water Power Reactors. Vienna, International Atomic Energy Agency, 1968.

From Symposium on Heavy-Water Power Reactors, Vienna, Austria. See STI/PUB-163; CONF-670917.

The metallurgical aspects of problems with the Halden Boiling Reactor fuel elements are presented. (auth)

30266 STUDY OF A HEAVY-WATER REACTOR WITH BOILING HEAVY-WATER COOLANT. Fonteray, J. (CEN, Saclay, France); Martin, R.; Thome, P.; Virnot, A. pp 809-30 of Heavy-Water Power Reactors. Vienna, International Atomic Energy Agency, 1968. (In French).

From Symposium on Heavy-Water Power Reactors, Vienna, Austria. See STI/PUB-163; CONF-670917.

The main features of boiling heavy water reactor projects, as well as the main technological problems raised by this design which relate to the thermal insulation of the concrete vessel in the presence of a two-phase fluid, the handling equipment which must function in steam at 300°C, and the accessibility of the exchangers are presented. (auth)

30267 SAFETY ASSESSMENT OF PRESSURE-TUBE HEAVY-WATER REACTORS BY PROBABILITY METHODS. Cave, L.; Williams, T. F. (Atomic Power Constructions Ltd., Sutton, Eng.). pp 831-63 of Heavy-Water Power Reactors. Vienna, International Atomic Energy Agency, 1968.

From Symposium on Heavy-Water Power Reactors, Vienna, Austria. See STI/PUB-163; CONF-670917.

The use of probability methods for the assessment of safety has been developed in the United Kingdom for gas-cooled reactors; the development of these methods has proceeded in parallel with a move towards the formulation of quantitative safety criteria; some possible criteria are described. In particular, a method has been developed which is of value for a rapid assessment of a preliminary design in order to reveal potential points of weakness before the design is finalized. The method is applied to the design of hypothetical 250-MW(e) reactors of both the indirect and direct cycle types in order to illustrate the use of this method for pressure-tube heavy-water reactors and also to provide a comparison of the safety of this reactor system and others, such as the United Kingdom advanced gas-cooled type. A difficulty in the use of probability methods at present is the scarcity of data on failure rates for structures and large items of plant. An essential feature of the method described is a perturbation of the assumed

failure rates by factors of order 100, to assess the effect of such uncertainties. The effect of major changes in other features important to safety, such as reliability of the containment systems, is also examined. (auth)

30268 IN-CORE INSTRUMENTATION: AN IMPORTANT TOOL FOR ACHIEVING HIGH SPECIFIC POWERS IN HEAVY-WATER REACTORS. Firing, J. A.; Kjaerheim, G.; Rolstad, E. (Institutt for Atomenergi, Halden, Norway). pp 865-81 of Heavy-Water Power Reactors. Vienna, International Atomic Energy Agency, 1968.

From Symposium on Heavy-Water Power Reactors, Vienna, Austria. See STI/PUB-163; CONF-670917.

An extensive line of in-core instruments has been developed and applied at HBWR, Norway. The instruments have proved to be reliable and are considered to be an important tool for achieving maximum power density in a core, which can only be done when the real limits have been determined and means found to safely operate the fuel assemblies close to those limits. The burn-out power limit, the channel instability limit and the center fuel temperature limits are the main factors which determine the maximum power of a natural circulation fuel channel of a boiling heavy-water reactor. At the present stage theoretical calculations are not sufficiently accurate to determine these limits. In-core measurements are therefore required. Instruments used to determine limiting fuel and channel characteristics are described. An in-core detector system to determine the power distribution in the core will be used in order to operate the fuel assemblies close to their power limits. This system can be with thermal neutron flux detectors, gamma flux detectors or by material activation method (i.e., wire scanning, aeroball system). The number and interpretation of signals from these systems require the use of a computer. The in-core instrumentation program on the Halden Reactor has already involved 40 instrumented fuel assemblies and more than 60 new assemblies will be used over the next two years. Together with a power detector system and the use of an on-line process computer, methods for power distribution determinations and optimal fuel usage will be sought and developed. (auth)

30269 COMPUTER CONTROL IN THE DOUGLAS POINT NUCLEAR POWER STATION. Siddall, E.; Smith, J. E. (Atomic Energy of Canada Ltd., Sheridan Park, Ont.). pp 883-903 of Heavy-Water Power Reactors. Vienna, International Atomic Energy Agency, 1968.

From Symposium on Heavy-Water Power Reactors, Vienna, Austria. See STI/PUB-163; CONF-670917.

The general nature of the problem of controlling and monitoring the operation of the Canadian heavy-water power reactors is described, and against this background the considerations leading to the belief in the major role to be played by digital computers in future plant control systems are discussed. In particular, the advantages and capabilities of the computer as a control device are described. The justification for the employment of a computer controller at Douglas Point is reviewed and the installation is placed in perspective with respect to the other automatic and manual control systems. The philosophy behind the design of the Douglas Point computer control system is reviewed with emphasis on the steps taken to obtain adequate overall availability and performance. The computer controller hardware and its capabilities are described together with a description of the computer program, its organization and the factors influencing its design. The functions performed by the Douglas Point computer system are reviewed with particular emphasis on the direct digital control functions. (auth)

30270 SURVEY AND CONTROL OF THE EL4 REACTOR. Martinot, G. (CEN, Saclay, France); Jacquin, J. C.; Leroy, C. pp 905-24 of Heavy-Water Power Reactors. Vienna, International Atomic Energy Agency, 1968. (In French).

From Symposium on Heavy-Water Power Reactors, Vienna, Austria. See STI/PUB-163; CONF-670917.

Survey and control of the EL4, where the degree of automation is comparable with that of the latest graphite-gas reactors being built, are nevertheless distinguished by the varying opportunities offered for operator intervention. A functional description of the facility includes: the regulatory systems; use of programmed and wired logic processes for surveillance and correction; the system of circuits ensuring safety of the reactor in respect of mechanical faults and defects in the survey process; and the technology of highly dependable ultimate safety circuits for emergency shut-down of the reactor using components intended solely for this purpose. (auth)

30271 EFFECT OF METHODS OF PURIFICATION OF THE ORGANIC COOLANT ON THE ECONOMY OF AN ORGEL POWER STATION. Terrien, J.-F.; Hannaert, H. (EURATOM, Ispra, Italy). pp 925-49 of Heavy-Water Power Reactors. Vienna, International Atomic Energy Agency, 1968. (In Italian).

From Symposium on Heavy-Water Power Reactors, Vienna, Austria. See STI/PUB-163; CONF-670917.

Various techniques can be considered to eliminate very high molecular weight impurity compounds which produce a deposit on the hot walls and increase the viscosity of the fluid. These techniques include: distillation; selective extraction of the HHB; and regeneration of the HHB by "hydrocracking." From the experimental results obtained at the CCR, Ispra, we determined for the first two techniques: equilibrium compositions of the coolant; cost of replacing the coolant; and cost of purification plants. With the help of these experimental data the effect on the cost of the power generated for the purification process, the amount of heavy compounds and the cost of the coolant are compared. (auth)

30272 CONTAINMENT VESSEL LEAKAGE UNDER MAXIMUM CREDIBLE ACCIDENT CONDITIONS. Philbin, Thomas William. Ann Arbor, Mich., Univ. of Michigan, 1967. 119p.

Thesis.

The acceptability of a reactor plant from the standpoint of safety is assessed by an analysis of the maximum credible accident, or MCA. For water-reactors with pressure type containment vessels, the MCA assumes leakage of the radioactive contaminants released in the accident in amounts based on pre-operational leak tests of the containment vessel with air. The implications of the differences between test and accident conditions on the expected leakage are examined. A typical pressure type containment vessel was simulated by an aluminum test chamber. Leakage from the test chamber was allowed to flow through steel leak models with diameters between 25 and 100 microns and lengths of 2.5 cm. The pre-operational leak tests are simulated by pressurizing the vessel with air at ambient temperature. The accident is simulated by pressurizing the test chamber with steam in the presence of either krypton or iodine, with Kr-85 or I-131 serving as the respective tracers. The leakage through the leak models was compared for both situations. An increased flow of krypton and iodine in the MCA situation over the test conditions resulted from condensing steam in the leak. A dependence of the leakage on temperature of the leak model was also observed. Deposition apparently had no effect on the I-131 flow rate. The condensed steam, however, proved capable of transporting significant amounts of iodine. Further, no plugging of the leak models by condensing steam was evident. The applicability of these results to reactor accident analyses is discussed. (Disser. Abstr.)

30273 CONTROLE ET ELECTRONIQUE DES REACTEURS NUCLEAIRES. (Control and Electronics of Nuclear Reactors). Furet, J. A la Meme Librairie. Paris, Masson et Cie, 1968. 267p.

Chapters of the given book contain material on: Elementary Physics of the Control of Reactors; Kinetics of Nuclear Reactors; The Neutron Detectors Utilized in Reactor Control; Associated Instrumentation for the Neutron Detectors; Safety in Reactor Control; and Dynamics and Control of Reactors. Included in appendices are: solution of the kinetic equations for a step increase in reactivity for the case of a single group of delayed neutrons; general solution for the kinetics equations for a ramp reactivity increase; asymptotic solution for the kinetics equations for a ramp reactivity increase; survey of the principal theorems of Boolean algebra; utilization of numerical techniques with electronic instrumentation and associated equipment for neutron detectors; and examples of recent development in electronic instrumentation associated with neutron detectors. (M.L.S.)

30274 EINFUEHRUNG IN DIE REAKTORPHYSIK. (Introduction to Reactor Physics). Fassbender, Josef. Thiemig-Taschenbuecher. Band 12. Munich, Verlag Karl Thiemig KG, 1967. 158p.

Elementary material on reactor physics is given. Nuclear structures and nuclear energies are described; the splitting of the nucleus is discussed. The mechanisms of reactions between neutrons and atomic nuclei are described; nuclear models are shown and some basic nuclear data are given. The mechanisms of chain reactions are discussed; definitions and descriptions of each term in the four-factor-formula are given. Slowing down of neutrons is discussed. Heterogeneous reactors are described; neutron diffusion and reactor equations are outlined. Discussions on the experimental determination of critical size, the function of the reflector, reactor kinetics, temperature coefficients, fission product buildup, and reactor control are given. Brief descriptions of fast reactors and breeder reactors are presented. 23 references. (M.L.S.)

30275 A LIQUID-COOLED NUCLEAR REACTOR. (to Licentia Patent-Verwaltungs-GmbH). British Patent 1,112,110. May 1, 1968. Priority date Sept. 1, 1964, Germany.

The description of a boiling water reactor is presented. Water enters the reactor core from the bottom, is heated in the core area, and surrenders the steam produced in a region above the core. The coolant returns to the bottom by means of an annular space between the reactor core and pressure vessel. Cylindrical steam separators are located in the annular space. (D.C.C.)

30276 BOILING HEAVY WATER REACTOR. Hannerz, Kare (to Allmanna Svenska Elektriska Aktiebolaget). U. S. Patent 3,375,171. Oct. 12, 1965. Priority date Oct. 23, 1964, Sweden.

A boiling heavy water reactor having a submerged, pressure regulated, separate moderator tank provided with a plurality of tubes extending from the inside of the moderator tank into a steam space of the reactor above the tank is described. During a fast shutdown of the reactor when pressure in the moderator tank is reduced, the tubes draw the heavy water steam into the cooler liquid moderator, where the steam is condensed. (U.S. Pat. Gazette)

30277 NUCLEAR REACTORS. Davey, Wesley Pearce; Burnup, Thomas Elliott (to United Kingdom Atomic Energy Authority). British Patent 1,112,213. May 1, 1968. Filed Apr. 28, 1966.

The description of containment systems for water-cooled reactors is presented. The primary containment contains an over pressure blow-off valve that is self re-sealing. The primary containment also contains baffles to limit flow rate. Vented gases from the primary containment to the secondary containment pass through similar conditions to be released to the atmosphere by a blow-off valve in the secondary containment. (D.C.C.)

Marine and Portable Power Reactors

30278 U. S. NUCLEAR-POWERED SUBMARINES. Beach, Edward L. US Nav. Inst., Proc., 93: 87-101(Aug. 1967).

An illustrated account is given of the specifications of nuclear-powered submarines of the U. S. Navy, in commission, under construction, and authorized. The length, surface and submerged displacement, armament, and type of nuclear power plant of each class are cited. (BBB)

30279 MOCKUP EXPERIMENTS FOR THE IRREGULAR SHIELD OF THE FIRST NUCLEAR SHIP OF JAPAN. Umeda, I. (Nippon Kokan KK, Yokohama, Japan); Toyoda, Y.; Nakano, Y.; Yamaki, H.; Fuse, T.; Miura, T.; Furuta, Y. Nucl. Eng. Design, 7: 152-8(1968).

Shielding mockup experiments were performed in order to obtain useful experimental data for complicated configurations of the primary shield of the first nuclear ship in Japan, a special cargo ship of 8350 gross tons, with a pressurized water reactor of 36 MW(t). Spatial distributions of gamma-ray dose rate and thermal neutron flux were measured around the primary shield mockups placed in the pool of JRR-4, a swimming pool type research reactor of 2.5 MW, installed at Japan Atomic Energy Research Institute for special shielding research purposes. The calculations were carried out to compare the experimental results using point kernel integration codes SPAN-3 and SPAN-SLAB. The computed results with SPAN-SLAB seem to give a rather good agreement with measured values for some points which were little influenced by air voids. But the calculated thermal neutron flux densities in the coolant nozzle, neglecting the streaming radiation through the nozzle, were less than the measured data by a factor of about 10. The experiments showed that the preliminary design is sufficient for the primary shield except around the coolant nozzle. The detail design will proceed taking the results of the mockup experiment into consideration. (auth)

Rocket and Space Reactors

Refer also to abstracts 27958 and 28085.

30280 (NUS-277) COMPARISON OF NUCLEAR AND EXPLOSIVE DESTRUCT CONCEPTS FOR NUCLEAR ROCKET ENGINES. De Agazio, Albert W. (NUS Corp., Washington, D. C. Environmental Safeguards Div.). May 1966. Contract SNPC-6. 59p. Dep. CFSTI.

In the event of premature re-entry of a nuclear rocket engine, it would probably be desirable to fragment the reactor core to minimize the radiation effects on the affected population. The nuclear stage can be equipped with chemical high explosives to destroy the core, or the reactor can be designed so that a rapid reactivity insertion will cause core fragmentation. The differences in fragmentation characteristics from these two methods are defined, and the consequent biological interactions resulting from the dispersal of radioactive particles are investigated. (H.D.R.)

30281 (SAN-679-6) DESIGN STUDY (OF) ELECTRICAL COMPONENT TECHNOLOGY FOR 0.25 TO 10.0 MEGAWATT SPACE POWER SYSTEMS: PARAMETRIC STUDY OF INDUCTOR ALTERNATORS. Kouba, C. C. (Westinghouse Electric Corp., Lima, Ohio. Aerospace Electrical Div.). Feb. 1968. Contract AT(04-3)-679. 249p. Dep. CFSTI.

Parametric studies to determine minimum system weight as a function of electrical rating, frequency, speed, voltage, and coolant temperature are presented on inductor alternators for ratings of 0.25 to 10.0 megawatts for space nuclear electric power plants utilizing the Rankine conversion cycle. (auth)

30282 (UCRL-50382) CONCEPTUAL DESIGN OF A 10-MW(e) NUCLEAR RANKINE SYSTEM FOR SPACE POWER. Pitts, J. H.; Walter, C. E. (California Univ., Livermore. Lawrence Radiation Lab.). Jan. 30, 1968. Contract W-7405-eng-48. 43p. Dep. CFSTI.

The conceptual design of a 10-MWe Rankine system for nuclear-electric space power is described. The system includes a compact nuclear reactor operating at 1650°K. The reactor design is based on uranium mononitride as the fuel, lithium as the coolant, and tungsten-25% rhenium as the structural material. An efficient heat-pipe radiator rejects waste heat at 1100°K. Overall system efficiency is 17.5%. (auth)

30283 (UCRL-70816) OUT-OF-CORE THERMIONIC SPACE POWER. Loewe, William E. (California Univ., Livermore. Lawrence Radiation Lab.). Mar. 8, 1968. Contract W-7405-eng-48. 10p. (CONF-680508-1). Dep. CFSTI.

From 2nd International Conference on Thermionic Electrical Power Generation, Stresa, Italy.

A survey of conceptual out-of-core thermionic systems using heat pipes has been made to identify critical technology areas, investigate feasibility for space application, locate parameter regimes of interest, and estimate specific mass values. The survey included preliminary comparisons of required, current, and projected state-of-the art in these critical areas of technology. Temperatures and powers were surveyed in the ranges from 1400°K to 2200°K and from .010 MW(e) to 10MW(e), respectively. A cylindrically symmetric geometry with a linear display of system components was studied. In general, out-of-core thermionic systems with heat pipes appear to be attractive candidates for use in space over a broad range of electric power levels, meeting the requirements of both advanced auxiliary power and nuclear (electric) propulsion. (auth)

30284 A LOOK AT NUCLEAR THERMIONIC SYSTEMS. Schreiber, Raemer E.; Salmi, Ernest W. (Los Alamos Scientific Lab., N. Mex.). Astronaut. Aeronaut., 6: 50-6(Jan. 1968).

Second-generation space nuclear-propulsion systems are reviewed. Present Rover concept technology and its logical extension will exploit the solid-fuel heat-exchanger systems, and there is little incentive to base any advanced concepts for future systems on variants of a solid-fueled reactor for direct-thrust rockets. A new propulsion system must offer substantial performance gains relative to the Rover system. For a nuclear-electric system applied to manned space exploration, this means a specific impulse (I_{sp}) of about 5000 sec and a weight-to-power ratio below 15 kg/kw (jet). A nuclear-electric drive consisting of an in-pile thermionic reactor combined with a low-voltage, high-current plasma thruster thus becomes a prime candidate for advanced propulsion systems. The proposed propulsion system's basic elements, the arcjet, heat pipe, and thermionic converter, are discussed and their present levels of development outlined. In parallel with the physics of thermionic conversion, there has been a development program on out-of-pile and in-pile converters. In-pile converters refer to reactor concepts which employ thermionic converters as the reactor fuel-element. Many of the major components of the in-pile thermionic system have been designed and tested and several reactor designs which have been studied are shown. However, much of the work has been exploratory in nature, and the difficulty of conducting in-pile tests in the available facilities has severely limited the systematic evaluation of performance in a realistic environment. It is proposed that an overall plan of thermionic development be established to include: application of existing technology to auxiliary space power supplies in the near future; development of a thermionic testing facility to permit the systematic assessment of components in a realistic reactor environment; and design and preliminary evaluation of complete reactor/converter/radiator/thruster systems, with particular emphasis on an early "breadboard" ground test. (BBB)

30285 COMPUTATION OF OPTIMAL CONTROLS FOR A NUCLEAR ROCKET REACTOR. Price, H. J.; Mohler, R. R.

(Univ. of New Mexico, Albuquerque). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: 65-73(Feb. 1968).

From 14th Nuclear Science Symposium, Los Angeles. See CONF-671026.

Various optimal reactor control problems with complicated constraints are solved for a nuclear rocket engine. The technique utilizes a digital computer with the numerical algorithm formed by a succession of linear programming problems. Each programming problem has a solution which is used to relinearize the system's dynamical equations. (auth)

30286 INHERENT CONTROL OF NUCLEAR PROPULSION REACTORS. Woyski, Jan S. (Douglas Aircraft Co., Santa Monica, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: 74-6(Feb. 1968).

From 14th Nuclear Science Symposium, Los Angeles. See CONF-671026.

Recent developments in the control of nuclear propulsion reactors are discussed. Analog simulation studies of engine performance have emphasized: (1) the use of hydrogen propellant moderating qualities for reactor power control, instead of neutron absorption in the control drums, and (2) the use of reactor temperature as the power reference, instead of neutron density. The concept of inherent control based on these two factors results in a smoother control function and in a simple and reliable control system. (auth)

30287 POTASSIUM RANKINE CYCLE TURBOELECTRIC SPACE POWER SYSTEM. Schnacke, A. W. (General Electric Co., Evendale, Ohio). Chem. Eng. Progr., 63: Symp. Ser., No. 75, 106-9(1967).

A nuclear Rankine cycle turboelectric space power system consists of a lithium-cooled reactor thermally coupled to a potassium power conversion system, which includes a heat exchanger boiler, turbogenerator, condenser radiator, and an electromagnetic boiler feed pump. The overall power system and the major components are illustrated. A salient feature is the vapor fin type of condensing radiator, which has unique features permitting flow circuit simplifications and providing a high degree of meteorite protection. (auth)

Process Heat and Desalination Reactors

Refer also to abstract 27630.

30288 (ORNL-4239) NUCLEAR DESALINATION PROGRAM. Annual Progress Report on Activities Sponsored by the Atomic Energy Commission for Period Ending October 31, 1967. Burwell, C. C.; Thompson, W. E. (comps.) (Oak Ridge National Lab., Tenn.). Apr. 1968. Contract W-7405-eng-26. 100p. Dep. CFSTI.

The results of development and engineering activities performed during the period November 1, 1966, through October 31, 1967, are summarized. General areas of study in the program to evaluate the potential of nuclear reactors for desalting applications include: analysis of desalting plant system coupling, dual-purpose plant control studies, large dual-purpose plant siting and safety studies, industrial applications of nuclear energy, and desalination reactor design studies and evaluations. Highlights of the development effort were: the design of an economically attractive 250-Mgd combined flash-vertical-tube evaporator plant, cost studies on industrial and agro-industrial complexes using desalted water, and studies of a low-temperature process heat breeder with unclad metal fuel and a liquid-metal coolant. (H.D.R.)

30289 (ORNL-TM-2049) STUDIES ON CONTROL OF BRINE HEATER LEAKAGE IN LARGE DUAL PURPOSE NUCLEAR DESALTING PLANTS. Kelley, W. H. (Oak Ridge National Lab., Tenn.). May 1968. Contract W-7405-eng-26. 143p. Dep. CFSTI.

The first large seawater desalination plants, of 50 Mgd and greater capacity, may utilize multistage flash evaporators and nuclear reactor power plants. Steam generated by the reactor plants will be used for the production of electrical power, and will be condensed in the brine heaters of the water plants furnishing heat for evaporation of the brine. Leakage within the brine heaters will result in some degree of contamination of the product water by the turbine exhaust steam and of the boiler feed water by salt from the brine stream. A study of the available literature on the effects of such leakage, and of design criteria and operational procedures which will minimize any hazardous effects is described. Factors which affect the transport, attenuation, and concentration of contaminants through the plant systems are evaluated. Also considered are the effects on the leakage problem of the plant control system, operating pressure levels, and variations in power and product water loads. (auth)

30290 CONCERNING THE GENERAL PROBLEMS OF THE SALINE WATER CONVERSION INCLUDING CONTROL REQUIREMENTS AND WATER SUPPLY SYSTEMS. Barluzzi, Francesco. pp 9-23 of Acqua e Energia Nucleare. La Desalinizzazione Delle Acque Marine. Barluzzi, Francesco. Rome, Comitato Nazionale Energia Nucleare, 1963. (In Italian).

International efforts for the conversion of saline water to potable water are summarised. Problems faced by the USA are discussed; US efforts in saline water conversion are described. Water requirements for the U. S. paper and steel industries are tabulated. Peak water load demand in Italy is discussed; industrial uses are tabulated. Use of reactors for salt water conversion is considered. (M.L.S.)

30291 ECONOMIC ASPECTS OF THE PROBLEMS IN THE CONVERSION OF SALINE WATER TO USEFUL WATER. Barluzzi, Francesco. pp 99-128 of Acqua e Energia Nucleare. La Desalinizzazione Delle Acque Marine. Barluzzi, Francesco. Rome, Comitato Nazionale Energia Nucleare, 1963. (In Italian).

A detailed cost breakdown for the various non-nuclear desalination systems is given; this is analysed in detail. Economics of nuclear desalination systems are listed; costs for potable water production from 370 MW to 957 MW reactors are tabulated. Projections of the use of reactors for desalination are made; economic factors involved are presented. 40 references. (M.L.S.)

30292 ECONOMICS: EFFECT OF WATER-POWER RATIOS AND THE ROLE OF DUAL PROCESS DUAL PURPOSE PLANTS. Chambers, S. (Atomic Energy Establishment, Winfrith, Eng.). J. Brit. Nucl. Energy Soc., 7: 49-59(Jan. 1968).

From Joint Symposium on Nuclear Desalination, London. See CONF-671054.

The effect of different costing procedures on the technical specification of the water plant in optimized dual purpose nuclear (AGR) multi-stage flash desalination plants is discussed, together with the corresponding product water costs. Limitations to the water/power ratio for gas-cooled and water-cooled reactors are discussed, and extension of the ratio by combined work/heat dual process methods is studied. Vapor compression combined with multi-stage flash distillation promises great flexibility and potential economy, but considerable development of compressors of large size is required before the benefits will accrue on the scale of operations appropriate to nuclear reactors. (auth)

30293 NUCLEAR ENERGY FOR THE SUPPLY OF HEAT. Barluzzi, Francesco. pp 71-97 of Acqua e Energia Nucleare. La Desalinizzazione Delle Acque Marine. Barluzzi, Francesco. Rome, Comitato Nazionale Energia Nucleare, 1963. (In Italian).

Use of nuclear energy for conversion of saline water is discussed. The requirements for fuels to produce the conversion energy are outlined. Distillation systems utilizing various types of reactors are considered; the reactor types are: thermal reactors with natural uranium, thermal reactors with enriched uranium, and fast reactors with highly enriched uranium. Design parameter requirements for reactors which are coupled with multiflash distillation units are tabulated. Overall effects of fission product heating and decay are considered. Industrial use of nuclear generated heat is discussed. (M.L.S.)

30294 SINGLE AND DUAL PURPOSE DESALINATION PLANTS. Clelland, David Watson (United Kingdom Atomic Energy Authority, Risley, Eng.). J. Brit. Nucl. Energy Soc., 7: 43-8(Jan. 1968).

From Joint Symposium on Nuclear Desalination, London. See CONF-671054.

An examination is made of some major technical and economic features of single purpose desalination systems with steam raised by oil-fired boilers, and large dual purpose power/water plants employing AGRs and SGHWRs. Attention is drawn to the relatively expensive water produced in single purpose systems, and the much lower costs which can be achieved in large nuclear-powered dual purpose plants. (auth)

30295 ACQUA E ENERGIA NUCLEARE. LA DESALINIZZAZIONE DELLE ACQUE MARINE. (Water and Nuclear Energy. The Desalination of Marine Waters). Barluzzi, Francesco. Rome, Comitato Nazionale Energia Nucleare, 1963. 134p.

Separate abstracts are prepared for each of the four sections on desalination of salt water and production of potable water. Uses of nuclear energy are stressed. (M.L.S.)

For abstracts of individual sections see: 27975, 30290, 30291, and 30293.

30296 DUAL STREAM HEAVY WATER–ORGANIC COOLED REACTOR CONCEPT. Cahn, Herbert. Troy, N. Y., Rensselaer Polytechnic Inst., 1967. 359p.

Thesis.

The Dual Stream reactor concept involves two physically separated coolant streams operating in parallel and utilizing the reactor heat to produce steam at two different temperatures. This concept is applied to a dual purpose HWOCR plant. The high temperature organic stream at 750°F is used for electric power production and to produce low temperature steam for desalination. The low temperature D_2O stream at 329°F is used for desalination only. The feasibility and ranges of parameters of a Dual Stream HWOCR are investigated and compared to a single stream HWOCR. Analysis of the nuclear, thermal, and hydraulic characteristics of the dual stream concept shows it to be technically feasible and to have distinct advantages over the single stream concept. (TSS) (Disser. Abstr.)

Research and Test Reactors and Critical Assemblies

Refer also to abstracts 28076, 28162, 28206, and 29873.

30297 (ARH–471) IGNITION AND BURNING CHARACTERISTICS OF ZPPR FUEL ALLOY. Felt, R. E. (Atlantic Richfield Hanford Co., Richland, Wash.). May 1, 1968. Contract AT(45-1)-2130. 11p. Dep. CFSTI.

The results of ignition and burning tests on 3 clad Zero Power Plutonium Reactor fuel plates and one unclad fuel plate are presented. The fuel alloy composition was 69% U, 3% Mo, and 28% Pu, and the cladding was stainless steel. The alloy burning characteristics resembled Pu, with a peak burn temperature of 825°C. It was more difficult to ignite than Pu and burned at a lower rate. Particle release from the alloy fire was less, and it was difficult to maintain the burning alloy in contact with a heat-removal surface such as the cladding without the addition of external heat. The fire hazard associated with a ZPRR fuel plate clad in stainless steel is considered to be very limited. (H.D.R.)

30298 (BNWL-SA–1488) NEUTRON DOSIMETRY FOR FAST-REACTOR IRRADIATION AND SURVEILLANCE TESTING. Yoshikawa, H. H.; McElroy, W. N. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Apr. 8, 1968. Contract AT(45-1)-1830. 16p. (CONF-680604–2). Dep. CFSTI.

From Symposium on Radiation Effects to Reactor Metals, San Francisco, Calif.

The procedure followed to assess the effectiveness of neutron irradiations in various facilities or in different positions of one reactor is described. The first step is determining the number of neutrons involved during the test. Next, the neutron spectrum is found, and the effectiveness of a neutron of energy E in causing the property change of interest is defined. This information is then combined to assess the irradiation effectiveness. Some examples of the application of the techniques are presented. (H.D.R.)

30299 (BNWL-SA–1750) FFTF FUEL DEVELOPMENT PROGRAM. Burgess, C. A.; Hanson, J. E.; Hayward, B. R. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Mar. 27, 1968. Contract AT(45-1)-1830. 22p. (CONF-680419–2). Dep. CFSTI.

From American Nuclear Society National Topical Meeting, Cincinnati, Ohio.

Fuel fabrication processes for the NPTF and FTR are described. Irradiation testing of the FTR driver fuel is also described. (D.C.C.)

30300 (BNWL-SA–1754) IRRADIATION TESTING FACILITIES: NEEDS, LIMITATIONS, AND AVAILABILITY. Arneson, S. O. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Apr. 1, 1968. Contract AT(45-1)-1830. 4p. (CONF-680419–1). Dep. CFSTI.

From American Nuclear Society National Topical Meeting, Cincinnati, Ohio.

The needs for fast reactor irradiation testing facilities are reviewed and the availability of testing reactors to meet the needs are discussed. Limitations of available facilities are identified and space requirements are compared with availability. The need for continued and improved availability of EBR-II for near term fast reactor fuels and materials testing is emphasized and alternate testing facilities such as Fermi are briefly reviewed. The overall testing capabilities of the Fast Flux Test Facility are discussed. (auth)

30301 (DOCKET-50231–16) SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR. Facility Description and Safety Analysis Report, Amendment 14, Suppl. 16. (General Electric Co., Sunnyvale, Calif. Advanced Products Operation). Apr. 29, 1968. 340p. Dep. CFSTI.

Design information on the SEFOR reactor vessel is given. Functional and design requirements are presented; fabrication methods and quality control are outlined. The surveillance program is described; installation of reactor vessel intervals and fuel channels is discussed. Appendices include: vessel procurement specifications; temperature distribution study; design analyses of the reactor vessel; and specifications for installation of reactor vessel intervals and fuel channels. (M.L.S.)

30302 (GA–8377) FAST REACTOR SPECTRUM MEASUREMENTS. Quarterly Progress Report for the Period Ending October 31, 1967. Preskitt, C. A. (Gulf General Atomic, Inc., San Diego, Calif.). Nov. 21, 1967. Contract AT(04-3)-177. 16p. Dep. CFSTI.

Construction of the Subcritical Time-of-Flight Spectrum Facility (STSF) is described; problems encountered are discussed. An inventory of core materials present for loading the STSF is tabulated. Core and reflector composition for STSF-1 is given; reactivities of various loadings are tabulated. Neutron spectra are shown for various locations with respect to core content. Reactivity transients resulting from unintentional criticality while closing the beds are shown as a function of time. (M.L.S.)

30303 (GEAP–5271) IMPLICATIONS OF RECENT FAST CRITICAL EXPERIMENTS ON BASIC FAST REACTOR DESIGN DATA AND CALCULATIONAL METHODS. Greebler, P.; Gyorey, G. L.; Hutchings, B. A.; Segal, B. M. (General Electric Co., Sunnyvale, Calif. Advanced Products Operation). Oct. 1967. Contract AT(04-3)-189. 37p. Dep. CFSTI.

Recent experimental information from dilute, Pu-fueled critical assemblies is used to test and to provide guidance for improving fast reactor design data and calculational methods. The experimental data are taken from ZPR-III Assembly 47 (the SEFOR core mockup) and ZPR-III Assembly 48. The important nuclear reactor parameters are calculated with a number of variations in nuclear data and calculational techniques. An analysis of the experimental and calculated results shows that by careful adjustment of the important cross sections, well within experimental uncertainties, and by improved accuracy in the calculational methods, a much closer agreement can be achieved between calculations and experiments than that heretofore reported. A complete evaluation is made of the cross-section and resonance parameter data for Pu-239, the most important isotope in this case. The new data yield good agreement with the critical masses of ZPR-III Assemblies 47 and 48. They result in a calculated ^{239}Pu Doppler effect that is essentially zero, in agreement with the measured values. A two-dimensional calculation of the neutron lifetime, using group constants that adequately account for the spatial variation of the neutron spectrum, yields a significant improvement over that based on a one-dimensional model. (50 references are included). (auth)

30304 (IAE–1401) NEKOTORYE VOPROSY REKONSTRUKTSII REAKTOROV TIPA IRT. (Some Aspects of the Modernizations of IRT Type Reactors). Chernyshevich, V. N.; Korneev, V. T.; Shavrov, P. I.; Egorenkov, P. M.; Dubovets, G. G.; Zhigachev, V. M. (Akademiya Nauk SSSR, Moscow. Institut Atomnoi Energii). 1967. 20p. (In Russian). Dep.

Construction and fabrication operations during the modernization of the IRT reactor at the Institute of Atomic Energy in I. V. Kurchator are described; working conditions are discussed with respect to background radiation levels and personnel exposure. Comments concerning the modernization of other existing and newly built IRT type reactors are presented. (tr-auth)

30305 (IAEA–3498–22) PROGRESS REPORT OF NORA PROJECT, JANUARY 1–MARCH 31, 1968. (Institutt for Atomenergi, Kjeller (Norway)). Apr. 1968. 42p. Dep. CFSTI.

Operation of the NORA reactor during the first quarter of 1968 is summarized. The major activity for the period was experimental and theoretical work on grey control elements introduced into various UO_2-H_2O cores in NORA. The grey control elements were all made from 1.07 and 2.82 mm thick stainless steel plates with 1.09 w/o natural boron content. Results of reactivity effects and thermal neutron spectrum effects calculations and macroscopic flux distribution, power distribution, and temperature coefficient measurements are presented. (H.D.R.)

30306 (IFA–FR–59) STUDY OF THE ACTIVATION PHENOMENA IN THE COOLING-WATER OF THE VVR-S REACTOR. Ionescu, E.; Alexan, Z. (Academia R.P.R., Bucharest. Institutul de Fizica Atomica). 1968. 8p. Dep.

Radioactive isotopes in the reactor cooling-water are obtained from the cooling water itself, cooling water impurities, fuel cladding, fuel material, structural material, and control rods and their impurities. Lists of radioisotopes present in the cooling-

water giving the abundance, source, radiation, and energy are presented. Samples of gamma-spectrometry measurements are presented. (D.C.C.)

30307 (ORNL-TM-2085) STUDY OF THE EFFECT OF EMPTY CHANNELS ON THE NEUTRON DIFFUSION COEFFICIENT IN GRAPHITE. Bennett, Leonard L. (Oak Ridge National Lab., Tenn.). Mar. 1968. Contract W-7405-eng-26. 71p. Dep. CFSTI.

Thesis. Submitted to Univ. of Tennessee [Knoxville].

The effect on the neutron diffusion coefficient of neutron streaming along empty channels is discussed using steady-state flux traverse and pulsed-neutron measurements. These measurements were made in the moderator structure of the Experimental Gas-Cooled Reactor with no control rods in the assembly and also with two different patterns of full length control rods. Using one-velocity diffusion theory, the axial component of the thermal neutron diffusion coefficient for each experimental configuration was obtained from the experimental results. The theory of Behrens was used to calculate the value for the diffusion coefficient parallel to the empty channels. This calculation was made for the empty moderator assembly with no control rods inserted. These results indicate that Behrens' formulas for the parallel neutron streaming corrections are quite good for this case. (auth)

30308 (SGAE-R-2/1967) EINRICHTUNG ZUR BESTRAHLUNG BIOLOGISCHER MATERIALIEN MIT SCHNELLEN NEUTRONEN IM ASTRA-REAKTOR. (Arrangement for Irradiation of Biological Material with Fast Neutrons in ASTRA-Reactor). Birtscher, A. (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Seibersdorf). Nov. 1967. 27p. (In German). Dep.

An installation for the irradiation of biological materials with fast neutrons outside the core of the ASTRA reactor was constructed and installed. The irradiation arrangement consists principally of a lead and boron shield for the attenuation of γ rays and thermal neutrons. The dose of highly ionizing particles, which are produced by (n,p) and (n,α) reactions with thermal neutrons, can be kept smaller than 0.5%. The ratio of the fast neutron dose to the γ dose is a function of the core distance. This ratio lies between 10 and 2 for the possible irradiation positions of the ASTRA reactor. With respect to the RBW factor, which, according to the measured effect and the irradiated material, lies in the range from 8 to 50, the effect of the γ dose in the irradiation installation is negligibly small in most cases. In the irradiation of biological materials with fast neutrons, dose outputs in the area of 1 to 5 rad/sec are available. The irradiation arrangement can be installed in a 5-MW swimming pool reactor 10 cm from the core, in which case dose rates over 100 rad/sec are attainable. (tr-auth)

30309 (TRG-Report-857) DOUNREAY FAST REACTOR CHARGE B/3. REACTION RATE MEASUREMENTS AND THEIR COMPARISON WITH CALCULATION. Loggie, R. G. C. (United Kingdom Atomic Energy Authority, Dounreay (Scotland). Reactor Group). Oct. 5, 1964. 20p. Dep. CFSTI. UK.

Fission chamber measurements of ^{235}U(n,f) and U(nat)(n,f) reaction rates, and experimentally determined ^{239}Pu production in the D.F.R. inner breeder, are compared with T.D.C. and CRAM computer calculations. Reasonable agreement is obtained for both the ^{235}U(n,f) and the ^{238}U(n,γ) reaction rates, but the calculated U(nat)(n,f) reaction rate is about 11% higher than experiment. (auth)

30310 (ORNL-tr-1787(Vol.1)) FAST FUEL ELEMENT TESTING REACTOR (P.E.C.). Preliminary Design Study. Section II. Volume 1. Text. (Comitato Nazionale per l'Energia Nucleare, Bologna (Italy)). Translated for Oak Ridge National Lab., Tenn., from report PRV-(66)45(Sect.2)(Vol.1). 280p. Dep. CFSTI. JCL $17.50 fs, $8.60 mf.

See also ORNL-tr-1787(Vol.2) for figures.

A complete description of the PEC reactor core and intervals is given; design parameters and drawings are included. Detailed information on fuel elements and control rods is given. Reactor operating conditions are tabulated. Test facilities are described; characteristics are given. Neutron shield data are given; sample shielding calculations are shown. The gamma spectrum used for shield calculations is tabulated. Fuel element handling equipment is described; operating procedures for fuel element tests are given. The coolant circuits are described; operations information is tabulated. The regulation and control systems are described. A description of the radiation monitoring system is given. Primary and secondary circuit instrumentation systems are listed; each system is discussed briefly. Safety instrumentation and alarm setpoints are tabulated; channel logic is indicated where applicable. The automatic data acquisition system is described briefly. The various buildings at the installation are described. Neutronic characteristics of the experimental facilities are tabulated. (34 references). (M.L.S.)

30311 (ORNL-tr-1787(Vol.2)) FAST FUEL ELEMENT TESTING REACTOR (P.E.C.). Preliminary Design Study. Section II. Volume 2. Figures. (Comitato Nazionale per l'Energia Nucleare, Bologna (Italy)). Translated for Oak Ridge National Lab., Tenn., from report (PRV-(66)45(Sect.2)(Vol.2). 162p. Dep. CFSTI. JCL $12.00 fs, $5.06 mf.

See also ORNL-tr-1787(Vol.1) for text.

A complete set of design drawings for the PEC fast reactors is given. (M.L.S.)

30312 A STUDY ON THE ZERO-PROBABILITY METHOD. Kobayashi, Takayuki (Kyoto Univ.). J. Nucl. Sci. Technol. (Tokyo), 5: 145-52(Apr. 1968).

Let us consider the probabilities p(n,t) and p_m(n,t), where p(n,t) is the probability that exactly n neutrons are found in the reactor at time $t > 0$ when a neutron had been injected at $t = 0$, and p_m(n,t) the probability that a neutron detector placed in the reactor counts exactly m neutrons during a time interval (0,t) and exactly n neutrons are found at time t when a neutron had been injected at $t = 0$. By formulating p(n,t) and p_m(n,t) in terms of last collision probabilities, linear partial differential equations for probability generating functions of p(n,t) and of p_m(n,t) have been derived. After solving these equations, the theory of zero-probability method is discussed. And it is shown that the probability P_0(t) of recording no count during a time interval t is a function of a decay time constant α of prompt neutron chains and t. Moreover, an experiment has been carried out on an assembly containing slightly enriched uranium. Rossi-α measurements and pulsed neutron measurements have also been made for verification. The parameter α measured by the zero-probability method does not agree well with those by the other methods. (auth)

30313 ANALYTICAL STUDY OF DYNAMICS OF A COMPACT NUCLEAR FAST SYSTEM. Musso, B. (CNEN, Rome). Energ. Nucl. (Milan), 15: 198-203(Mar. 1968).

An approximate analytical solution of the reactor dynamics equations including the temperature feedback is given under the general conditions of external reactivity insertion, provided the system does not reach prompt-criticality. This method is applied to the evaluation of transients for the TAPIRO fast source reactor and the results are compared with those obtained by more sophisticated analog computations. Good agreement in the comparison of results shows accuracy for preliminary analysis. (auth)

30314 BR3/VULCAIN CORE PERFORMANCE: THEORETICAL AND EXPERIMENTAL ASPECTS. De Waegh, F. (Belgo-Nucleaire, S. A., Brussels). pp 39-52 of Heavy-Water Power Reactors. Vienna, International Atomic Energy Agency, 1968.

From Symposium on Heavy-Water Power Reactors, Vienna, Austria. See STI/PUB-163; CONF-670917.

The BR3/Vulcain power experiment is primarily aimed at testing under actual reactor conditions the high-performance fuel elements designed for Vulcain cores; these are cooled and moderated by a mixture of heavy and light water whose composition is modified progressively as burn-up proceeds. The BR3/Vulcain detailed core performance analysis included neutronic, heat transfer and hydraulic studies both for steady state and transient conditions. The methods of neutronic calculations used for this analysis were extensively checked against measurements performed in 1964 and 1965 in the VENUS critical facility at Mol. Burn-out experiments were carried out at Winfrith on a bundle of rods closely simulating the geometry of the actual fuel elements. In addition, hydraulic flow tests were performed at REL (UKAEA) to determine the coolant distribution at the inlet of the core and along the fuel assemblies. A comparison is given of the main core neutronic parameters as calculated and measured in the course of the BR3/Vulcain reactor. Further measurements were carried out in March 1967 when the core reached a mean irradiation of 3000 MWd/t U and have confirmed the agreement between measured and predicted values. Additional series of physics measurements are planned when the core will reach mean irradiations of about 9000, 17,000 and 25,000 MWd/t U. (auth)

30315 CALCULATION OF BUCKLING CORRESPONDING TO λ^* IN THE CASE OF PULSED BeO ASSEMBLIES. Navalcar, M. P. (Bhabha Atomic Research Centre, Trombay, India). J. Nucl. Energy, 22: 257-9(Apr. 1968).

A brief summary is presented of calculations by two-group diffusion theory of the buckling and maximum limit of the decay constant (λ^*) in finite pulsed BeO assemblies. It is shown that an asymptotic decay constant does not exist for $B^2 > 0.027$ cm^{-2}. This is in good agreement with the experimental results of Ritchie and Rainbow [Nucl. Sci. Eng., 28: 301 (1967)]. (UK)

30316 CONTROL BLADES FOR THE HIGH FLUX BEAM REACTOR. Godel, J. B.; Hendrie, J. M. (Brookhaven National Lab., Upton, N. Y.). Nucl. Appl., 4: 418-24(June 1968). (BNL-11801).

The High Flux Beam Reactor at Brookhaven is controlled by neutron absorbing blades that contain 30 vol % Eu_2O_3 or Dy_2O_3 dispersed in stainless steel. The europium oxide is used in areas of high burn-up. The rare-earth compacts are rolled into 0.132-in.-thick plates that are clad with ≥0.20-in. stainless steel. Four such plates are electron beam welded to form an angle-shaped blade with a central cooling channel. After ~11,000 MWd of service and exposure to almost 2×10^{21} n cm^{-2}, the blades continue to perform satisfactorily in this D_2O-cooled and -moderated research reactor. (8 references) (auth)

30317 DIGITAL COMPUTER CONTROL OF A RESEARCH REACTOR. Takumi, K.; Taguchi, T. (Hitachi Ltd., Tokyo). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: 87-92(Feb. 1968).

From 14th Nuclear Science Symposium, Los Angeles. See CONF-671026.

Described is a feasibility experiment for a fully automatic operation of Hitachi Training Reactor, employing a digital computer control system. The system consists of a small control computer (2K words), input-output peripherals, 3 BF_3 counters, and a control rod mechanism driven by a pulse motor. (auth)

30318 EXPERIENCE GAINED FROM THE FINAL CONSTRUCTION PHASE AND THE APPROACH OF POWER OF RAPSODIE. Gajac, G.; Reynes, L. Bull. Inform. Sci. Tech. (Paris), No. 124: 63-74(Mar. 1968). (In French).

The different problems encountered during startup testing time and particularly the two incidents (with sodium leakage) which led to important modifications in the concept of certain structures and apparatus are described. Detection of sodium leakage as well as means to limit consequences of possible leakage have been particularly reinforced following these incidents. (auth)

30319 FURTHER REACTOR PHYSICS STUDIES FOR STEAM GENERATING HEAVY WATER REACTORS. PART 2. MULTI-ZONE CORES FOR FUEL MANAGEMENT STUDIES. Briggs, A. J.; Johnstone, I.; Newmarch, D. A.; Kendall, K. C. (United Kingdom Atomic Energy Establishment, Winfrith, Eng.). J. Brit. Nucl. Energy Soc., 7: 125-45(Apr. 1968).

A number of multi-zone cores were investigated in DIMPLE and JUNO to test the METHUSELAH-AIMAZ method of predicting power distributions and reactivities in SGHW design and performance calculations. The range of experiments included cores with two radial zones, chess-board cores and three-batch roundelay cores. Channel perturbation effects and reflector effects were also studied, and measurements with fuels containing up to 8 kg/Te of plutonium were included to simulate the burn-up of feed enrichment SGHW fuel to a mean irradiation of 21,000 MWd/Te. (auth)

30320 IMPORTANCE OF UPSCATTERING IN THE CALCULATION OF NEUTRON SPECTRA. Bollacasa, D. (United Nuclear Corp., White Plains, N. Y.); Goldman, D. T. pp 537-53 of Neutron Thermalization and Reactor Spectra. Vol. I. Vienna, International Atomic Energy Agency, 1968.

From IAEA Symposium on Neutron Thermalization and Reactor Spectra, Ann Arbor, Mich. See STI/PUB-160(Vol.1); CONF-670707-(Vol.1).

A study has been made of the effect of raising the thermal energy cut-off higher than 0.625 eV. In most neutron thermalization calculations, the assumption is made that there is no upscattering above 0.625 eV. This may be a poor assumption especially for moderator models with chemically bound hydrogen even at room temperature. In the study, a thermal cut-off energy of 3.06 eV was chosen. This was done because the upscattering above this energy is small and this energy corresponds to that of a group in a slowing-down programme used in the calculations. Neutron spectra and group-averaged cross-sections were computed and the inadequacy of a thermal cut-off of 0.625 eV was manifested by comparisons between calculations at these energy cut-offs. A discontinuity can be observed in joining the thermal and ipithermal fluxes at 0.625 eV, while the joining is smooth at 3.06 eV. This provides the possibility of directly normalizing the thermal neutron source to the slowing-down density from the epithermal energy region. Thus, neutron spectra in the thermal and epithermal energy regions can be calculated in one process. Comparisons were made in group constants with no upscattering included between 0.625 and 3.06 eV and with upscattering included up to 3.06 eV. A spectrum calculation for a SHA (a small homogeneous assembly) fuel element was compared to a measurement made of its asymptotic spectrum. Even though the agreement between calculation and experiment was not exact, the calculated spectrum closely matched the measured spectrum above 0.625 eV. 9 references. (auth)

30321 MEAN NEUTRON DENSITY IN HETEROGENEOUS MEDIA. Stepanov, A. V. (Lebedev Inst. of Physics, Moscow). pp 193-222 of Neutron Thermalization and Reactor Spectra. Vol. I. Vienna, International Atomic Energy Agency, 1968. (In Russian).

From IAEA Symposium on Neutron Thermalization and Reactor Spectra, Ann Arbor, Mich. See STI/PUB-160(Vol.1); CONF-670707-(Vol.1).

The passage of neutrons through a heterogeneous medium, which may be described using the Boltzmann equation with fluctuating parameters, is described. An approximate expression is derived for the neutron flux averaged over the fluctuations in the medium, and is valid for small fluctuations. The mean neutron flux is analysed as a function of time and energy. A periodic reactor lattice is considered as an example of a heterogeneous medium. (auth)

30322 MEASUREMENT OF SHUTDOWN MARGIN. Pedersen, Knud (Univ., Puerto Rico, Mayaguez); Murphy, Glenn. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: 46-56(Feb. 1968).

From 14th Nuclear Science Symposium, Los Angeles. See CONF-671026.

A method was developed and investigated for directly measuring the shutdown margin in a reactor operating at a subcritical steady state. Measurements were made on the Iowa State University UTR-10 reactor with conditions ranging from almost critical to fully shutdown. The method is based on the fact that the frequency dependent transfer function of the reactor is a measure of the response of the reactor to an input disturbance. A sinusoidal disturbance was introduced by means of an oscillator operating in the center of the core. The oscillator was operated at a fixed frequency of 10 cps in order to eliminate the frequency dependence. The fluctuation was measured by a BF_3 detector located against the outside of the core opposite the oscillator. The signal was passed through a band-pass filter and was then cross-correlated with a pure sine wave to obtain the transfer function. A plot of the transfer function vs. the multiplication factor was a smooth function from which the multiplication factor could be found with a confidence of ±0.04% near critical and with a confidence of ±0.17% in the fully shutdown condition. Reproducibility of the plot was excellent even when a different detector was used. (auth)

30323 MEASUREMENTS OF THE NEUTRON DIFFUSION PARAMETERS IN GRAPHITE OF THE ANNA REACTOR. Chwaszczewski, Stefan; Mikulski, Andrzej Tadeusz; Dybowski, Kazimierz (Inst. of Nuclear Research, Swierk, Poland). Nukleonika, 13: 153-64(1968).

The parameters (Σ_a^x) and D in graphite of the ANNA reactor have been measured by the pulsed neutron source method based on the determination of the decay constant for several space dependent distributions of higher harmonics. The results: $(\Sigma_a^x) = 79 \pm 3\ s^{-1}$ and $D = (211 \pm 5) \cdot 10^3\ cm^2\ s^{-1}$ (for $\rho = 1.7\ g\ cm^{-3}$ and temperature 20 ± 4°C) are in agreement with other measurements. These results prove that the graphite in the ANNA reactor is in agreement with the standards generally accepted for nuclear grade graphite. (auth)

30324 NEUTRON BEAM ENRICHMENT BY TRANSMISSION IN A TOTAL REFLECTING CONICAL TUBE. Cambiaghi, M.; Fossati, F.; Pinelli, T. (Univ., Pavia, Italy. Istituto Nazionale di Fisica Nucleare, Pavia, Italy). Nucl. Instrum. Methods, 62: 233-6(June 15, 1968).

A total reflecting conical tube with an internal optical surface has been realized in order to collimate a neutron beam to be used in beam-hole fission experiments. The gain in the current density and the thermal spectrum enrichment have been calculated in the used geometrical arrangement. The calculated data have been checked experimentally and the collimator surface reflectivity of about 0.6 has been evaluated. The thermal spectrum of the total neutrons emerging from the conical tube has such a behavior that the average cross section for 1/V target is about the double of that relative to the thermal Maxwell distribution with no reflected neutrons. (auth)

30325 NEUTRON POSITION-DEPENDENT SPECTRUM IN A MULTIPLYING ASSEMBLY. Cerbone, R. J.; Slovacek, R. E.; Gaerttner, E. R. (Rensselaer Polytechnic Inst., Troy, N. Y.). Contract AT(30-3)-328. pp 61-75 of Neutron Thermalization and Reactor Spectra. Vol. II. Vienna, International Atomic Energy Agency, 1968.

From IAEA Symposium on Neutron Thermalization and Reactor Spectra, Ann Arbor, Mich. See STI/PUB-160(Vol.2); CONF-670707-(Vol.2).

The neutron thermal spectrum has been measured at several positions in a paraffin-moderated ^{235}U multiplying assembly using two experimental techniques. At each position, the steady-state spectrum was obtained with the time-of-flight technique using the Rensselaer Polytechnic Institute Linear Accelerator as a pulsed-

neutron source in conjunction with a 24.4-m neutron flight path; the asymptotic (in time) spectrum was obtained utilizing the pulsed-linac phased chopper technique. The multiplying assembly was composed of a mixture of paraffin, ZrO_2 powder and UO_2 powder; the medium hydrogen number density was approximately one-third as great as in pure polyethylene. A reentrant hole perturbation study was made experimentally on the spectral shape and intensity; no change in shape was observed and the intensity change was less than 3% upon enlarging the hole diameter up to 0.75 in. Measurement of the correct thermal extrapolation length in a pure moderating assembly of the same hydrogen density and first-order hole perturbation calculations also confirm this small perturbation result. A new technique was also developed to monitor the source intensity using a 'standard' source and only one neutron detector system for both the standard source and the multiplying assembly. This monitor technique was shown to have a tracking deviation of less than 1.5% over an eight-hour period of time. The measured spectra were compared with transport calculations of the position-dependent spectrum using the DTF IV programme with an added anisotropic source option. The calculations were performed with a P_1 polyethylene kernel using the Goldman and the Koppel-Young models. The P_0 and P_1 components of the spatial source were also obtained from transport calculations; the EET programme was used to obtain the source at 1.60 eV using a multi-regional calculation. The steady-state surface angular flux intensity was too low by 15% if the materials in the shield region were not included explicitly in the source determination. The P_1 source contribution was approximately 25% at the surface. The measured spectra were found to be in better agreement (less than 5% deviations) with the spectrum calculations using the Goldman kernel. The polyethylene total cross-section was also found by Armstrong to agree better with the Goldman model whose oscillator weights were adjusted to match the high-energy total cross-section. Although the Koppel-Young model, which has a firmer physical basis, fits the doubly differential cross-section shapes better, it does not yield integral values of the inelastic scattering cross-section. (auth)

30326 NEUTRON SPECTRA IN SUBCRITICAL GRAPHITE- AND BERYLLIA-MODERATED ASSEMBLIES. Jakeman, D.; Hardiman, J. P. (Atomic Energy Establishment, Winfrith, Eng.). pp 93-110 of Neutron Thermalization and Reactor Spectra. Vol. II. Vienna, International Atomic Energy Agency, 1968.

From IAEA Symposium on Neutron Thermalization and Reactor Spectra, Ann Arbor, Mich. See STI/PUB-160(Vol.2); CONF-670707-(Vol.2).

A number of subcritical graphite- and beryllia-moderated assemblies fueled with plutonium and highly enriched uranium plates have been constructed with ratios of moderator atoms to fissile atoms as low as 300. As part of a general study of these small undermoderated systems in which fission takes place predominantly at energies above 0.1 eV, time-of-flight measurements have been carried out using a neutron chopper having a resolution of 4 μ s/m. This adequately resolves the spectrum in the thermal region and in the region of the resonance in ^{239}Pu at 0.296 eV. Calculations have been carried out using a multigroup transport code with scattering matrices for graphite and beryllia based on data obtained from the Chalk River scattering law experiments. A correct weighting over the experimental source area of the vector flux in the direction of the extracted beam produces a spectrum which can be compared directly with the observed spectrum. It has been found that in the region 0.4 to 1.0 eV the experimental spectra have fewer neutrons than are predicted and this is particularly noticeable in the BeO-moderated assemblies. The factors which could give rise to the discrepancy are discussed but it has not been possible to attribute it to any particular one. (auth)

30327 PRESENT STATUS OF CANADIAN ORGANIC-COOLED REACTOR TECHNOLOGY. Mooradian, A. J.; Robertson, R. F. S.; Hatcher, S. R.; Hart, R. G.; Tegart, D. R.; Summach, A. J. (Atomic Energy of Canada Ltd., Pinawa, Manitoba). pp 383-98 of Heavy-Water Power Reactors. Vienna, International Atomic Energy Agency, 1968.

From Symposium on Heavy-Water Power Reactors, Vienna, Austria. See STI/PUB-163; CONF-670917.

Canada has been operating the first organic-cooled D_2O-moderated pressure-tube reactor (WR-1) since November 1965. The operation of WR-1 and the supporting development programs at the Whiteshell Nuclear Research Establishment are described. (auth)

30328 RELATION BETWEEN THE STABLE REACTOR PERIOD AND THE PROMPT NEUTRON TIME CONSTANT IN THE ANNA REACTOR. Chwaszczewski, Stefan; Mikulski, Andrzej Tadeusz; Jablonski, Konrad (Inst. of Nuclear Research, Swierk, Poland). Nukleonika, 13: 141-52(1968).

The relation between the stable reactor period and the prompt neutron time constant is discussed for a complicated reactor system. It is shown theoretically that this relation may be practically described by the inhour equation. To support this conclusion, measurements were taken at the ANNA critical assembly. For pulsed measurements of the prompt time constants near the critical state, a special device for decreasing the delayed neutron background was constructed. It has been shown that the prompt reactor period in a critical state may be determined more accurately by simultaneous measurements of the prompt time constant and the stable reactor period. (auth)

30329 RESONANCE ABSORPTION MEASUREMENTS TO EVALUATE SPECTRUM CALCULATIONS FOR A SUBCRITICAL LATTICE. Carver, J. G.; Porter, C. R. (General Electric Co., Pleasanton, Calif.). pp 49-60 of Neutron Thermalization and Reactor Spectra. Vol. II. Vienna, International Atomic Energy Agency, 1968.

From IAEA Symposium on Neutron Thermalization and Reactor Spectra, Ann Arbor, Mich. See STI/PUB-160(Vol.2); CONF-670707-(Vol.2).

Six resonance absorbers, together with Cu as a 1/v detector, have been used to investigate spectral variations with position and temperature, within a subcritical lattice of plutonium-enriched fuel rods in a light-water moderator. The resonance absorbers used (and the energies of their principal resonances) were ^{176}Lu(0.143 eV), ^{168}Yb(0.597 eV), ^{191}Ir(0.654 eV), ^{193}Ir(1.303 eV), ^{197}Au(4.906 eV), and ^{140}La(73.5 eV). The metallic Ir and Au were dissolved in Zr to dilute them; the other four materials were diluted by dissolving their oxides in a sodium-free glass. These blended materials were drawn into cylindrical rods 0.159 cm in diameter and cut into segments 0.238 cm long. Concentrations of the resonance materials were adjusted so that the cylinder diameter was 0.01 mean free path for neutrons at the resonance energy. These cylindrical "foils" were activated at the center of a special fuel rod, at the outer surface of the fuel (inside the cladding) and in the center of the water gap between fuel rods. Separate sets of foils were activated at 70 and 540°F, with the subcritical lattice installed in a pressure vessel to permit the latter measurements. Relative activation rates in the Cu, and in the resonance absorbers, were predicted using space-dependent neutron spectra calculated with the THERMOS code below 0.8171 eV and the EPITHERMOS code from 0.8171 eV to 1.3 eV; 1/E dependence was assumed above 1.3 eV. Comparisons between prediction and measurement were made by comparing ratios of resonance activity to Cu activity (for example, Lu-Cu ratios). It was found that the measurements confirmed predicted variations of these ratios with position in the unit cell. This close agreement was not obtained for variations of the ratios with temperature. For example, the Lu-Cu ratios, (measured at fuel rod surface and center), increased by less than 60% between 70 and 540°F, compared with predicted increases of 67 to 73% for this temperature change. Since the precision of the measured ratios was approximately 2%, this comparison indicates the need for re-examination of the analysis method which was used. (auth)

30330 RESULTS OF THE ESSOR ZERO-POWER EXPERIMENTS. Hage, W.; Ligou, J.; Riesch, G. (EURATOM-CCR, Ispra, Italy). pp 655-79 of Heavy-Water Power Reactors. Vienna, International Atomic Energy Agency, 1968.

From Symposium on Heavy-Water Power Reactors, Vienna, Austria. See STI/PUB-163; CONF-670917.

A series of critical experiments on the fuel element test reactor ESSOR has been performed during April, May and June 1967. The purpose of the experiments was to confirm the ESSOR design calculations, to obtain experimental data for extreme fuel test zone loadings and to test different theoretical models. From this intercomparison the appropriate theory will be selected to calculate power reactor operation data in order to avoid, as far as possible, later zero-power experiments with an altered test-zone. A brief description of the reactor in zero-power condition is given. The experimental program was chosen such that the driver zone, the control and safety rod and the different types of test fuel element calculations could be independently checked. Experimental data are reported on two-core configurations, one with the driver zone only, and one with the test zone consisting of natural uranium and slightly enriched fuel elements of cluster type. The fuel elements were simulated in reactivity for power conditions. Measurements of the core reactivity, the control rod reactivity, the flux distribution and reactivity perturbations are compared with theoretical design calculations. (auth)

30331 SAFETY PROBLEMS CONCERNING THE OPERATION OF THE BR.5 REACTOR. Orlov, V. V.; Pinkhasik, M. S.; Aristarkhov, N. M.; Efimov, I. A.; Karpov, A. V.; Nikulin, M. P. (Comite d'Etat pour l'Utilisation de l'Energie Nucleaire, Moscow).

Bull. Inform. Sci. Tech. (Paris), No. 124, 75-86(Mar. 1968). (In French).

The sodium cooled reactor BR.5, in operation since January 1959, has been operating 37,700 hrs as of July 1, 1967 (11,200 hrs at 5 MW). The outlet temperature which had been set at 450°C has been set at 500°C since 1960. The burn-up has reached 7% while the design provided 2% rate. Operation was continued in spite of release of fission products and clad rupture. In 1965 the reactor was fueled with UC. With the use of cold traps the oxide percentage was kept below 3×10^{-6}%. The reactor was shut down several times, the reasons for these shut downs are analyzed. (auth)

30332 SPECTRAL ANALYSIS OF FAST NEUTRONS FROM TRIGA MARK-II. Lee, Yung Jae (Atomic Energy Research Inst., Seoul). J. Nucl. Sci. (Seoul), 7: No. 1, 21-6(Oct. 1967).

The spectrum of fast neutrons leaking through the radial piercing beam tube of the TRIGA MARK-II was measured by the nuclear emulsion method. The emulsion plates were exposed to the collimated neutron beams of 1 cm × 1 cm size at the beam port. The measured spectrum is well fitted by the curve $F(E_n) = (27.85 \pm 2.29) \exp(-1.035E_n) \sqrt{E_n}$. This is compared with the thermal fission neutron spectrum. (auth)

30333 SPECTROCALORIMETRIC MEASUREMENT OF ENERGY-FLUX DENSITY OF THE PHOTON FIELD IN THE ACTIVE ZONE OF A REACTOR. Kott, Josef (Nuclear Power Plant Div., Plzen). Tech. Dig. (Prague), 10: 3-7(Jan. 1968).

Use of calorimeter systems for measuring energy-flux field of the photon field is described. The mathematical basis for the use of calorimeters is outlined; the spectrocalorimetric probe is described. Measurements in the WWR-S research reactor are detailed; results are tabulated and shown graphically. Absorbed dose is shown as a function of distance; the effective energy of various calorimeter combinations is tabulated. (13 references). (M.L.S.)

30334 SUB-CRITICAL MEASUREMENTS OF BUCKLING AND MIGRATION AREA USING SPONTANEOUS FISSION AS THE PRIMARY NEUTRON SOURCE. Ahmad, M.; Harris, M. J. (Univ. of Manchester, Eng.). J. Phys., D, 1: 645-51(May 1968).

Using spontaneous fission as the sole primary neutron source, measurements were made of the lattice constants of a sub-critical assembly fuelled with natural uranium rods of 1.2 in. diameter and moderated by water ($V_m/V_u = 1.43$). The experimental procedure is described and a simple two-group analysis is developed for interpreting the measurements. The thermal neutron fluxes were low, being of the order of 25 neutrons/cm^2 s; nevertheless the buckling was determined as $-(6.80 \pm 0.42)\ 10^{-4}$ cm^{-2}, a value in good agreement with that obtained from conventional exponential experiments. (auth)

30335 THE SIEMENS TRAINING REACTOR SUR. Szirmai, E. (Univ., Stuttgart). Nucl. Energy, 58-9(Mar.-Apr. 1968).

The SUR 100 is a thermal, solid homogeneous reactor fuelled by 20% enriched U_3O_8 dispersed in a polyethylene moderator. The reactor design, experimental facilities, control, and instrumentation are briefly described, and the main parameters are listed. (UK)

30336 THERMAL AND EPITHERMAL NEUTRON SPECTRA IN HETEROGENEOUS SYSTEMS. Johansson, E. (Aktiebolaget Atomenergi, Stockholm). pp 77-92 of Neutron Thermalization and Reactor Spectra. Vol. II. Vienna, International Atomic Energy Agency, 1968.

From IAEA Symposium on Neutron Thermalization and Reactor Spectra, Ann Arbor, Mich. See STI/PUB-160(Vol.2); CONF-670707-(Vol.2).

Thermal and epithermal neutron spectra have been measured with the fast chopper at the Swedish reactor R1 (U,D_2O). The first experiments were carried out on beams from scatterers placed in a reactor channel giving the typical moderator spectrum of the lattice. Later on, the scatterers were replaced by various cells for measurements of scalar-flux spectra inside fuels, especially inside uranium tubes. Scalar-flux spectra were also measured in the center of a UO_2 cluster and also inside a UO_2 tube. The measurements on the UO_2 tube were done for oxide temperatures up to 750°C. The neutron beams analysed in these experiments on scalar-flux spectra in cells were obtained from lead cylinders (scatterers). Experiments on angular-flux spectra have also been done—on a cell consisting of uranium rods in D_2O. Most of the experiments have been accompanied by calculations with the THERMOS code. (auth)

30337 TRANSFER FUNCTION MEASUREMENTS ON THE UNIVERSITIES' RESEARCH REACTOR AT RISLEY. Jeffers, D. E. (Univ. of Manchester, Eng.); Corpus, G. J. Brit. Nucl. Energy Soc., 7: 146-50(Apr. 1968).

The transfer functions of the reactor were measured for a range of powers and coolant flow rates. Calculated values of the fuel element and moderator temperatures, and the measured transfer functions were used to determine the temperature coefficients of reactivity of the fuel and moderator. (auth)

30338 ZERO-REACTIVITY METHOD IN NUCLEAR PARAMETER EVALUATION OF HEAVY-WATER POWER REACTORS. Baccolini, A.; Casali, F.; Casini, G.; Giacobbi, V.; Hage, W.; Rustichelli, F.; Sturm, B. (CNEN, Bologna. EURATOM, Ispra, Italy). pp 643-53 of Heavy-Water Power Reactors. Vienna, International Atomic Energy Agency, 1968.

From Symposium on Heavy-Water Power Reactors, Vienna, Austria. See STI/PUB-163; CONF-670917.

A series of k_∞ measurements by the zero-reactivity method and by detailed parameter determinations has been carried out jointly by CNEN and EURATOM at the RB-1 reactor of Montecuccolino (Bologna), Italy. The aim of the experiments was to supply data for the development of the ORGEL-type reactor, to investigate the feasibility of the zero-reactivity method and to test the the reliability of the nuclear codes used. The experimental data were compared with the same quantities inferred from theoretical evaluations and with the results of substitution measurements performed at the ECO critical facility of Ispra. The fuel elements used were 19-rod uranium metal and 7-rod uranium carbide clusters, organic cooled. From the experimental and theoretical analysis it appeared that the results from the zero-reactivity method were consistent with the results obtained by the other experimental techniques and the theoretical calculations. It is to be outlined that, in the zero-reactivity experiments, the buffer region was constituted by only 8 ORGEL elements which represents an attractive economical advantage compared with other techniques. Moreover, it seems that when small changes in the test elements are involved, the measurement can be performed leaving the same buffer region without seriously affecting the accuracy of the results. (auth)

30339 MEASUREMENT OF RADIAL POWER DISTRIBUTIONS IN A TRIGA FUEL ELEMENT DURING REACTOR EXCURSIONS. Goodwin, William Allen. Urbana, Ill., Univ. of Illinois, 1967. 140p.

Thesis.

A TRIGA Mark II fuel element was instrumented with fourteen thermocouples located at various radial positions. The temperature in the element was measured as a function of radius and time during a series of power excursions (pulses) having reactivity insertions varying from $1.50 to $2.50. The $2.50 pulses were characterized by a six millisecond exponential period and a maximum power of 500 megawatts. The experimental temperatures were used to solve the time-dependent heat conduction equation for the heat generation rate as a function of radius and time during each pulse. Since most of the energy of fission is deposited locally in the form of fission fragment kinetic energy, the calculated heat generation rates are proportional to the local fission rates. During a substantial portion of each pulse, the temperatures were found to increase adiabatically. The calculations showed that the power profile (the radial power distribution normalized to the centerline value) did not vary during a pulse. The profile was also found to be independent of the size of the pulse. The uncertainty in the normalized powers was estimated to be about two percent. It was concluded from these observations that within the accuracy of the experiment the power profile was independent of fuel temperature. The power profile was found, however, to be influenced by the local environment of the element. Profiles measured while the instrumented element was surrounded by water were more depressed than those measured when the element was in a region having a high fuel-to-water ratio. The calculated power distributions showed the flux gradients that exist in the TRIGA core. Pulses performed with the instrumented element at the center of the core demonstrated that there is a flux gradient across the center due to flux peaking in the water holes left by the partially withdrawn control rods. Experiments performed with the instrumented element in various other core locations demonstrated that within the accuracy of the experiment no change in the gross power shape across the core was observed during a pulse. This fact confirmed that the kinetic description of the TRIGA core is separable in space and time. The calculation of power profiles from steady state temperature distributions was found to be very sensitive to small errors in the measured temperatures. Due to a nonuniform bond between the fuel and cladding, some scatter existed in the experimental points that defined the radial temperature distribution. The amount of scatter was not large, but was enough to prohibit the calculation of a unique and meaningful power profile. Attempts were also made to calculate

radial power distributions several seconds after the peak of a pulse. At this point in time, the rate of change of the power is small, but large quantities of heat are being discharged to the coolant. As in the steady state case, the conduction errors prevented the determination of accurate radial power distributions. (TSS) (Disser. Abstr.)

30340 THE SPINS AND MOMENTS OF ^{117}Sb AND ^{118m}Sb. Jackson, Andrew Dumont Jr. Princeton, N. J., Princeton Univ., 1967. 148p.

Thesis.

The spins and hyperfine structures (HFS) of ^{117}Sb (2.7 hr) and ^{118m}Sb (3.5 min) were determined using conventional atomic beam magnetic resonance techniques. These isotopes were produced by (p,n) reactions on enriched tin targets in the Princeton University cyclotron. ^{117}Sb was made with the internal beam and transferred to an off-line atomic beam apparatus. ^{118m}Sb was produced directly in the oven chamber of an on-line atomic beam apparatus using the external proton beam. The spin measurements gave $I_{117} = {}^5/_2$ and $I_{118m} = 1$. The measured HFS constants are $A_{117} = -237.8(2)$ MHz, $B_{117} = -5.4(4)$ MHz, and $|A_{118m}| = 545(24)$ MHz. The corresponding magnetic dipole and electric quadrupole moments are $\mu_{117} = +2.672(10)$ nm, $|\mu_{118m}| = 2.45(12)$ nm, and $Q_{117} = -0.29(3)$ b. The results of first-order configuration mixing correlations to the magnetic moments using both zero-range and realistic force matrix elements are discussed. (Diss. Abstr.)

30341 ELEMENTARY REACTOR EXPERIMENTATION. Biehl, A. T.; Geckler, R. P.; Kahn, S.; Mainhardt, R. (eds.). San Ramon, Calif., Aerojet-General Nucleonics, 1957. 208p. (NP-17450).

In connection with the development and manufacture of the AGN 201 training reactor, a training program was developed for Aerojet-General Nucleonics employees and customers. The text of the training program provides a basis for learning the elements of reactor and nuclear technology. Although written primarily for use with the AGN 201, much of the information and many of the procedures and experiments are applicable to other systems. (H.D.R.)

30342 IMPROVEMENTS IN OR RELATING TO DAM GATE ASSEMBLIES. Taylor, Donald Garden; Touhey, John William (to United Kingdom Atomic Energy Authority). British Patent 1,111,801. May, 1, 1968. Filed Mar. 10, 1965.

The description of a dam gate for controlling water levels in two reservoirs is presented. The reservoir system provides shielding water for a nuclear reactor. The dam gate is located between an adjoining wall of the reservoirs and consists of a vertically slidable gate. The gate slides in a guide frame with a resilient seal on one side of the gate and a flexible hollow member on the other side of the gate. The flexible hollow member is inflatable to secure the seals. (D.C.C.)

Reactor Theory, Components, Fuels and Accessories

Refer also to abstracts 27952, 27953, 27960, 27970, 28063, 28251, 28747, 28777, 28846, 28893, 28895, 28897–28899, 28903, 28904, 28907, 28910–28913, 28915, 28934, 29831, 29833, 29834, 29843, 29853, 29856–29862, 29865–29870, 29872, and 29874–29876.

30343 (EURAEC-1992) USE OF PLUTONIUM AS FUEL IN NUCLEAR REACTORS. Quarterly Report No. 16. Bairiot, H.; Lhost, A.; Deramaix, P. (Centre d'Etude de l'Energie Nucleaire, Brussels (Belgium). Societe Belge pour l'Industrie Nucleaire Brussels). Jan. 1968. Contract 001-64-1-TRUB. 66p. (EUR-3787). Dep. CFSTI.

Work performed under United States–Euratom Joint Research and Development Program.

REACTOR FUEL ELEMENTS—fabrication of mixed-oxide, powder filling and tamping characteristics for; fabrication by pneumatic vibration of powders, value gripper device for; heat transfer characteristics of mixed-oxide, effect of longitudinal enrichment profile on, (T); radiation testing of mixed-oxide, local maximum power measurements in; burnup ratio measurements on mixed-oxide; isotopic composition analysis of irradiated mixed-oxide; neutron buckling measurements in lattices of, precision of radial

ZIRCALOY-2—welding characteristics of, for use as fuel canning

FLUORINE—determination in mixed-oxide fuels by indirect titration

CARBON—determination in mixed-oxide fuels

FISSION PRODUCTS—release rates from mixed-oxide fuel elements, tapping measurements of

PLUTONIUM—diffusion in irradiated mixed-oxide fuel rods, (E/T)

PLUTONIUM-240—neutron cross section resonance broadening at 1.05 eV with temperature, (T)

CRITICALITY STUDIES—neutron physics analysis of plutonium oxide (PuO_2)–uranium oxide (UO_2)–water lattices using PANTHER code; neutron physics measurements on subcritical VENUS-Vulcain fuel assemblies

REACTIVITY—effect of fuel element fabrication, process on, (E)

PLUTONIUM OXIDES PuO—distribution in mixed-oxide fuel elements, variation of radial, (E); PuO_2–UO_2, fabrication and testing of, for use as reactor fuel

URANIUM OXIDES UO_2—distribution in mixed-oxide fuel elements, variation of radial, (E)

REACTOR FUELS—use of plutonium as, development during Oct. to Dec. 1967 (H.D.R.)

30344 (IFA-FR-53) MONTE CARLO METHOD IN REACTOR CALCULATIONS. Rosescu, Teodor (Academia R.P.R., Bucharest. Institutul de Fizica Atomica). 1966. 49p. Dep.

Included are 377 references on the application of the Monte Carlo method in nuclear reactor physics calculations. A brief subject index is also included. (H.D.R.)

30345 (KAPL-M-6914) CALCULATION OF FUEL PLATE FLUX AND CENTRAL TEMPERATURE. Jordan, W. B. (Knolls Atomic Power Lab., Schenectady, N. Y.). Mar. 15, 1968. Contract W-31-109-eng-52. 18p. Dep. CFSTI.

A simple graphical procedure is given for calculating peak heat flux and peak central temperature in a fuel plate. Results are compared with those computed by a more elaborate method and show discrepancies of less than 1%. (auth)

30346 (RISO-M-684) DESCRIPTION OF THE URU-PROGRAMME. Oelgaard, P. L. (Danish Atomic Energy Commission, Risoe. Research Establishment). Jan. 1968. 47p. Dep.

The URU-programme was prepared to allow an assessment of the natural uranium consumption of different types of uranium-fuelled thermal reactors, i.e. non-breeders. In the first part of the programme the number of MW(e)d, the Pu-production and the amount of remaining U, all per t nat. U, are calculated. In the second part the integrated uranium consumption and plutonium production are calculated as functions of time for a system of reactors of a given type and with specified total capacity and power production. The cases of no recycling, of uranium cycling only and of plutonium and uranium recycling are considered. A derivation of the formulas used, instructions for the use of the programme, a print-out of the programme, and a test example are presented. (auth)

30347 (TID-24342) EVALUATION OF EXPERIMENTAL AND THEORETICAL DATA ON RADIAL NOZZLES IN PRESSURE VESSELS. Rodabaugh, E. C.; Atterbury, T. J.; Cloud, R. L.; Witt, F. J. (Battelle Memorial Inst., Columbus, Ohio). [1967]. Contract W-7405-eng-92. 239p. Dep. CFSTI.

Included in six sections are data on radial nozzles in pressure vessels. The first three sections are on nozzles in spherical shells. The last three sections are on nozzles in cylindrical shells. Sections 1 and 4 contain proposed design procedures for nozzles with internal pressure loading. These two sections also contain a brief description of the development of the design procedures and comparisons with other design procedures. Sections 2 and 5 cover external loadings as well as internal pressure. Comparisons are made between a number of theories and between those theories and test data. Section 2 includes an Appendix giving graphs for obtaining stresses for nozzles in spherical shells due to internal pressure, external loads or combinations thereof. Section 5 includes an Appendix giving tables of stresses for nozzles in cylindrical shells due to internal pressure loading. Sections 3 and 6 cover the subject of flexibility of nozzles in pressure vessels. The flexibility of the nozzle is significant where the nozzle is attached to a piping system and the external loads on the nozzle arise from piping expansion. (auth)

30348 (WAPD-TM-661) SOLUTION OF THE SLAB TRANSPORT PROBLEM. Lois, Lambros (Bettis Atomic Power Lab., Pittsburgh, Pa.). Mar. 1968. Contract AT(11-1)-Gen-14. 57p. Dep. CFSTI.

A solution of the slab one-dimensional problem with energy degradation and arbitrary scattering is presented. An analytic solution of the one velocity, one region source free problem, is used as the basis for the entire problem. This solution is supplemented with an analytic solution for the one velocity, one region problem with distributed sources. They are extended to the many region problem and finally a slowing down scheme is added based on the group method. Code MO648 solves this problem; however, the

slowing down matrix and group constants must be inputed. Program MO756 will solve the problem for gamma rays, but the slowing down matrix and the group cross sections are also calculated. (auth)

30349 (WAPD-TM-730) PROOFS OF THE UNIQUENESS AND POSITIVITY OF THE SOLUTION VECTOR FOR VARIOUS APPROXIMATIONS TO THE FIXED SOURCE TIME INDEPENDENT NEUTRON TRANSPORT EQUATION. Rampolla, D. S. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Apr. 1968. Contract AT-11-1-GEN-14. 27p. Dep. CFSTI.

A straightforward method is used to prove the positivity and uniqueness of the solution to the time independent fixed source Boltzmann equation and several commonly used approximations. This method provides some interesting insight into the structure of the equations, and can readily be applied to other inhomogeneous equations. (auth)

30350 (WAPD-TM-755) NONLINEAR CONTINUUM CREEP MODEL FOR THE SWELLING OF CERAMIC NUCLEAR FUELS (LWBR DEVELOPMENT PROGRAM). Small, N. C. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Apr. 1968. Contract AT-11-1-GEN-14. 31p. Dep. CFSTI.

A nonlinear continuum model is described for the creep swelling of ceramic nuclear fuel materials. The theory includes the effects of fabricated porosity, fission induced porosity and surface tension. The same macroscopic dilatational element is utilized in the form of a hollow (fabricated pore) spherical element whose annulus is composed of analogous microscopic hollow (fission pore) spherical-sub-elements. A three dimensional theory is developed, and this is subsequently specialized to the case of one dimensional strain. Numerical results are given and discussed for this latter case. (auth)

30351 APPLICATION OF TIME-SYNTHESIS TECHNIQUES TO COUPLED CORE REACTORS. Yasinsky, J. B. (Bettis Atomic Power Lab., West Mifflin, Pa.). Nucl. Sci. Eng., 32: 425-9(1968).

The application to coupled core reactor problems of the multimode time synthesis approximation using trial functions $H_k(r)$ which are easily obtained is described. (D.C.C.)

30352 CORRELATION OF SIMILAR REACTIVITIES IN DIFFERENT REACTORS. Dideikin, T. S.; Shishin, B. P. At. Energ. (USSR), 24: 380(Apr. 1968). (In Russian).

Measurements of the reactivity of a central rod in a critical water moderated reactor with various concentrations of active zone poisoning by uniformly distributed thermal neutron absorber at various rod bank heights were obtained; the curve of the efficiency of central absorption of the rod is given as a function of neutron breeding factor. The data obtained indicate that further analysis of reactivity values is required for correlating the theoretical and experimental data. (R.V.J.)

30353 CREEP BUCKLING OF FUEL ELEMENT CLADDINGS. Gluekler, E.; Passig, E.; Hoechel, J. (Allgemeine Elektricitaets-Gesellschaft Grosswelzheim, Ger.). Nucl. Eng. Design, 7: 236-48(1968). (In German).

Based on theoretical work of Hoff et al. and Ellington on the creep buckling of tubes under external pressure, the equations to calculate the ovality increase of fuel element claddings under external pressure are derived. The theory of Ellington, the applicability of which is restricted to low values of Norton's creep parameter n, is generalized to all n values. Hoff's model is supplemented in so far as a time dependent decrease of the external pressure due to fission gas release can be considered now. In contrast with Hoff's method, Ellington's model yields the change of the clad diameter in addition to the ovality change, which gives a more comprehensive description of the long term clad behavior. With the aid of the generally derived equations the creep buckling behavior of fuel rods for a fast steam cooled reactor (DSR) with 7 mm OD, 0.4 mm wall-thickness, and commercial fabrication ovality is calculated. As critical time (life time), both the time to double the initial ovality and the time to collapse is considered. Moreover the influence of a certain linear decrease of the external pressure differential on the increase of the allowable initial pressure differential is demonstrated. Experimental results of autoclave tests with evacuated and welded tubing samples in high pressure, high temperature steam environment showed a satisfactory agreement with theory. (auth)

30354 DEVELOPMENT OF LARGE STEEL VESSELS IN LAMINATED CONSTRUCTION. Jorde, J.; Mueller, R.; Schulte, D.; Bretfeld, H. (Friedische Krupp GmbH, Essen). Kerntechnik, 10: 198-207(Apr. 1968). (In German).

The development of large steel pressure vessels in laminated construction is described. Examples are discussed illustrating construction, calculation, manufacturing and measurement procedures for two elements of pressure vessels—the vessel wall and the ports. (auth)

30355 DIRECT AND NONLINEAR PROGRAMMING APPROACH TO THE OPTIMAL NUCLEAR REACTOR SHUTDOWN CONTROL. Tabak, Daniel (General Electric Co., Philadelphia). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: 57-9(Feb. 1968).

From 14th Nuclear Science Symposium, Los Angeles. See CONF-671026.

The problem of optimal shutdown control of nuclear reactors for xenon poisoning is examined. The minimax problem is first solved using direct differentiation. Then, a modified time optimal problem is formulated and solved using Nonlinear Programming, thereby bypassing the difficulties created by Dynamic Programming and the Maximum Principle approaches used previously. Results of computational examples, using the new method, are presented and compared with the previous ones. (auth)

30356 EFFECT OF FISSION DENSITY ON FISSION-GAS RELEASE. Carroll, R. M.; Sisman, O.; Perez, R. B. (Oak Ridge National Lab., Tenn.). Nucl. Sci. Eng., 32: 430-1(1968).

The assumption that the fractional fission-gas release from UO_2 is not affected by fission density is based on the premise that either a diffusion or couple diffusion-trapping process controls the gas release and neither process is changed by fission density. Data showing the influence of fission density on the fractional fission-gas release are presented. (D.C.C.)

30357 EXACT TREATMENT OF THE RESONANCE ABSORPTION OF NEUTRONS OF INTERMEDIATE ENERGY. Ishiguro, Yukio (Japan Atomic Energy Research Inst., Tokyo). Nucl. Sci. Eng., 32: 422-5(1968).

An analytic expression for calculating the intermediate resonance integral that also gives exact results for the non-narrow resonance moderator systems is derived. (D.C.C.)

30358 INTERRELATION OF NUCLEAR REACTOR KINETIC EXPERIMENTS. Russell, J. L. Jr. (Gulf General Atomic Inc., San Diego, Calif.); Rotter, W. Nucl. Sci. Eng., 32: 417-31(1968).

Measurements used to investigate the kinetic properties of reactors consist of observing responses of the system to a time-dependent neutron source. The measurements include pulsed-neutron source techniques, neutron wave experiments, transfer function techniques, and source jerk techniques. The proof derivation that these measurements are related by a simple mathematical expression, which is exact for the case of zero power reactors, is presented. In the derivation the space and energy effects are automatically included exactly because the time-dependent neutron source of the accelerator is assumed to be separable in time and energy. (D.C.C.)

30359 INVESTIGATION OF NUCLEAR REACTOR EQUILIBRIUM STATE STABILITY ON BASIS OF ONE-GROUP DIFFUSION THEORY EQUATIONS. Postnikov, I. S.; Sabaev, E. F. At. Energ. (USSR), 24: 38-42(Jan. 1968). (In Russian).

The stability of the stationary regime of reactors was examined in the one-group diffusion approximation. For the case of local reciprocal coupling, the output-reactivity, described by a system of linear differential equations in the conventional derivatives, by means of the second method of Lyapunov, produced sufficient stability criteria. It was shown that in exceptional cases of spatially independent kinetic equations, the Belton-Smeta criterion results from the stability criterion obtained. (tr-auth)

30360 LONGITUDINAL LAMINAR FLUID FLOW IN A BUNDLE OF RODS. Sholokhov, A. A.; Buleev, N. I.; Gribanov, Yu. I.; Minashin, V. E. Inzh.-Fiz. Zh., 14: 389-94(Mar. 1968). (In Russian).

Analog and finite difference method solutions have been obtained for the longitudinal incompressible viscous flow between cylinders arranged in triangular or square array. The results are presented in the form of pressure drop and velocity distribution characteristics of systems under investigation. The results are given for a wide range of pitch-to-diameter ratios and compared with the data available in literature. The presented results are of practical importance in the calculation of pressure drop and coolant velocity distribution in a nuclear reactor core consisting of cylindrical fuel elements. (auth)

30361 NUCLEAR FUEL CYCLE SERVICES IN THE UNITED KINGDOM. Franklin, N. L. (United Kingdom Atomic Energy Authority, Capenhurst, Eng.). Atom, No. 139, 126-30(May 1968).

Topics discussed include: history of the UK industry; part played by Capenhurst diffusion plant; standardized fuel; production levels; reactor choice; and problems of development. (UK)

30362 NUCLEAR RESONANCE SPACINGS AND SYNTHETIC KERNELS. Wilkins, C. A. (Wollongong University Coll., New South Wales); Chiarella, C.; Gilks, A. J.; Reichel, A. Nucl. Sci. Eng., 32: 420-2(1968).

The general approach to problems involving the distribution of nuclear resonance spacings in reactor theory is to use approximations to this distribution. The equation derivation for the use of synthetic kernels in analyzing resonance spacing problems is presented. (D.C.C.)

30363 ON THE STABILITY OF HOMOGENEOUS NUCLEAR REACTORS. Alberton, S.; Cellina, A.; Szego, G. P. (Univ., Milan). J. Franklin Inst., 284: 279-82(Nov. 1967).

A homogeneous nuclear reactor is considered as an indirect control system of the Lur'e type with the usual substitutions. A new Liupanov function for the system is defined by applying an extension theorem and the Kalman-Iacubovich lemma. It can be shown then that the equilibrium point of the system is globally asymptotically stable, as long as the matrix of the system is stable; the system is asymptotically stable also in linear approximation for certain small real numbers. Not every solution to the reactor equations meets the criterion set by this theorem; trajectories of equilibrium points going to infinity with increasing time are shown to correspond to negative neutron density and thereby have no physical meaning. The question of the relation between this new criterion and the original Popov criterion is not yet determined; it must be established which of these gives the larger stability region. (BBB)

30364 OPTIMIZATION OF NUCLEAR REACTOR FUEL RECYCLE VIA LINEAR AND QUADRATIC PROGRAMMING. Tabak, Daniel (General Electric Co., Philadelphia). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: 60-4(Feb. 1968).

From 14th Nuclear Science Symposium, Los Angeles. See CONF-671026.

The possibility of applying Linear or Quadratic Programming to the problem of optimizing nuclear reactor fuel recycle is investigated. It is demonstrated that the methods mentioned may be applied successfully to a simplified model of a nuclear reactor. An appropriate representation of the fuel recycle as a feedback control system is proposed. An iterative algorithm to establish the refueling times, which are unknown a priori, is formulated and implemented to some specific examples. The convergence of the algorithm has been established numerically. (auth)

30365 RELIABILITY OF RADIATION-CHEMICAL INSTALLATIONS. Kozlov, Yu. D.; Titkov, Yu. S.; Breger, A. Kh.; Paderno, I. P. At. Energ. (USSR), 24: 378-9(Apr. 1968). (In Russian).

Technological aspects of radio-chemical installations (^{60}Co and ^{137}Cs γ-ray sources, electron accelerators and nuclear reactors which utilize fission products, radiative circuits or γ-emitting fuel elements) are evaluated. Their lifetime, efficiency, and steady performance are considered. The tabulated data indicate that, at identical conditions, the continuous performance P_e = const. of the radiochemical installations with isotopic sources is higher than the installations using accelerators. (R.V.J.)

30366 STATISTICAL ANALYSIS OF STATIC POWER TILTING IN REACTORS DUE TO MANUFACTURING TOLERANCES. Judge, F. D. (Knolls Atomic Power Lab., Schenectady, N. Y.). Nucl. Sci. Eng., 32: 429-30(1968).

Large power factor uncertainties in reactors may arise due to uncertainties associated with manufacturing tolerances of fuel and poison loadings and moderator volumes. These uncertainties are separated into those which affect the gross power in various large regions of the core and those which alter local power factors within a given region. It is often the practice to determine the gross power tilt allowance by running detailed calculations in which the k_∞ of certain specific areas are changed by an amount equal to the variance of the as-built reactivity level. The remainder of the core is assumed to be nominal. The validity of this practice and assumption is established. (D.C.C.)

30367 STUDY ON THE TEMPERATURE EFFECT COUPLING IN REACTOR RADIATION ATTENUATION ANALYSIS. Szymendera, L. (Inst. of Nuclear Research, Warsaw). Nucl. Eng. Design, 7: 201-22(1968).

Nuclear radiation flux density distributions and radiation induced temperature fields are mutually dependent. An attempt is made to improve the RASH-method for reactor radiation attenuation analysis by treating the nuclear parameters not as constant data but as temperature dependent variables. For solving the problem in coupled form, the perturbation method and the method of successive approximations are used. A numerical example is given which illustrates the effect of temperature coupling in the case of nonhydrogeneous material. (auth)

30368 THERMAL BUCKLING OF NONHOMOGENEOUS PLATES. Dewey, Bruce R. (Univ. of Tennessee, Knoxville); Costello, George A. Nucl. Eng. Design, 7: 249-61(1968).

Thermal buckling of flat plates is treated through the use of a method utilizing the second variation of the potential energy. The method is developed in detail for simply supported plates where the modulus of elasticity varies as a consequence of nonuniform heating. The results when simplified for homogeneous material agree favorably with published data. A limited experimental verification using epoxy plates gives favorable agreement with the theory. This work has possible application to flat reactor fuel plates and structural members when nonhomogeneity may be an important factor. (auth)

30369 TIME AND ENERGY DEPENDENCE OF NEUTRON FLUX DISTRIBUTIONS. Trombetti, T. (CNEN, Bologna). Energ. Nucl. (Milan), 15: 173-85(Mar. 1968).

The space-time and space-energy neutron flux distributions in infinite homogeneous media with constant cross sections and δ-like sources are examined. Systematic use of the duality resulting between the time and energy variables is made in order to give the Laplace and Fourier transforms of the n-th Legendre harmonic of the neutron flux general formulae which are valid in both physical situations. These formulae are then exactly inverted to obtain the original flux. Applications to some physical cases are discussed. (D.C.C.)

30370 ADVANCES IN NEUTRON THERMALIZATION THEORY. A REVIEW. Kuscer, I. (Univ. of Ljubljana, Yugoslavia). pp 3-26 of Neutron Thermalization and Reactor Spectra. Vol. I. Vienna, International Atomic Energy Agency, 1968.

From IAEA Symposium on Neutron Thermalization and Reactor Spectra, Ann Arbor, Mich. See STI/PUB-160(Vol.1); CONF-670707-(Vol.1).

Parallel with further development of pulsed-neutron experiments and related techniques, thermalization theory has devoted much attention to eigenvalue problems of the transport equation, to problems of relaxation times and relaxation lengths, and to the related problem of neutron waves. In each of the three quoted cases part of the spectrum covers a continuum corresponding to singular eigenfunctions. Outside the continuum there may be a finite or sometimes infinite set of discrete eigenvalues, associated with regular eigenfunctions. These eigenvalues disappear, one by one, by reaching the edge of the continuum if a characteristic parameter of the system is varied in a certain sense. Thus all the space-eigenvalues disappear if too much absorber is added to the medium. Discrete time-eigenvalues cease to exist if the size of the system is made sufficiently small. And no regular neutron waves are possible beyond a critical frequency. The puzzling phenomenon of so-called pseudo-discrete eigenvalues which in experiments with crystalline media have been found to invade the continuum has recently been clarified by careful analysis of a suitable model. Solutions of eigenvalue problems are needed for predicting the values of diffusion parameters. They are also a prerequisite for solving the initial-value problem by the Laplace transform technique. For the time-dependent Green's function this leads to a bi-linear form in terms of the eigenfunctions; to this a 'transient' term, in the form of an integral along the edge of the continuum, must be added. Unfortunately, many of the mathematical steps involved in this procedure are still tentative and the proofs are missing. In the development of methods of solution, problems with slab geometry have as usual been predominant. Approximate methods have often produced satisfactory results. Also the exact methods of Wiener and Hopf, and of Case, have been generalized to energy-dependent transport theory. However, practical success has in both cases been limited to simple models. A reciprocity property of the Green's function has helped to obtain from diffusion theory easy asymptotic solutions of a few standard problems. Some methods have been exchanged with the kinetic theory of gases, where similar eigenvalue, initial-value and boundary-value problems have arisen. An occasional link to radiative transfer has also been established. 121 references. (auth)

30371 EXISTENCE OF A DIFFUSION LENGTH IN A FINITE PRISM OF PURE MODERATOR. Williams, M. M. R. (London Univ.). pp 27-43 of Neutron Thermalization and Reactor Spectra. Vol. I. Vienna, International Atomic Energy Agency, 1968.

From IAEA Symposium on Neutron Thermalization and Reactor Spectra, Ann Arbor, Mich. See STI/PUB-160(Vol.1); CONF-670707-(Vol.1).

An exact integral transport equation is derived for the neutron flux in a finite prism of pure moderator. Assuming that the prism is infinite in the z-direction, a trial solution $\exp(-\nu z)$ is inserted, and an eigenvalue problem for ν, the spatial relaxation constant, results. The eigenvalue ν is studied as a function of the absorption and dimensions of the prism. It is shown that the

discrete eigenvalues are bounded by Σ_{min} and that a minimum dimension exists below which a diffusion length can no longer be found. This result is much more restrictive than the maximum absorption theorem of Corngold, and the minimum dimension of the prism is shown to correspond to transverse bucklings of 10^{-3} cm^{-2} for beryllium, and 1.5×10^{-3} cm^{-2} for graphite, at 300°K. The angular distribution of the neutrons in the moderator has been calculated perpendicular and parallel to the axis, and it is found that a marked anisotropy of the spectrum exists, particularly in the neighborhood of the Bragg cut-off. On the basis of degenerate kernel approximation to the scattering process, it is shown that when the system is such that no diffusion length exists, then the asymptotic transverse flux shape is no longer of the cosine type, but becomes progressively flatter as the distance from the source increases. This is due to an increase in the proportion of cold neutrons which have longer mean free paths than the average. The well-known cold neutron filtering effect can be explained in terms of this phenomenon. (auth)

30372 TIME-DEPENDENT THERMALIZATION WITH ELASTIC SCATTERING. Borysiewicz, M.; Mika, J. (Inst. of Nuclear Research, Swierk, Poland). pp 45-52 of Neutron Thermalization and Reactor Spectra. Vol. I. Vienna, International Atomic Energy Agency, 1968.

From IAEA Symposium on Neutron Thermalization and Reactor Spectra, Ann Arbor, Mich. See STI/PUB-160(Vol.1); CONF-670707-(Vol.1).

The time-dependent transport equation describing the behavior of thermal neutrons in a sample of moderator is discussed. The rigorous analysis of this problem with the assumption of isotropic scattering was reported by Albertoni and Montagnini for the free gas and by Bednarz for the crystalline moderator at the IAEA Symposium on Pulsed Neutron Research at Karlsruhe, May 1965. However, the results of Bednarz did not include the elastic scattering which plays an important role in crystals. The isotropic elastic scattering kernel is not square-integrable after symmetrization like the free gas kernel or the inelastic part of the scattering kernel in solids. However, it is shown that the essential features of the transport operator and, in particular, its spectrum, remain unchanged. This important fact enables the use of the transport theoretical interpretation of pulsed neutron experiments in solids. (auth)

30373 USE OF A SYSTEM OF LAGUERRE POLYNOMIALS AND RELATED FUNCTIONS IN SOLVING VARIOUS THERMALIZATION PROBLEMS. Laletin, N. I.; Pasynkov, I. G. (Inst. of Atomic Energy, Moscow). pp 53-62 of Neutron Thermalization and Reactor Spectra. Vol. I. Vienna, International Atomic Energy Agency, 1968. (In Russian).

From IAEA Symposium on Neutron Thermalization and Reactor Spectra, Ann Arbor, Mich. See STI/PUB-160(Vol.1); CONF-670707-(Vol.1).

A uniform and effective method of solving thermalization problems involving fast neutron sources in the spatial region is considered. In such problems the thermal neutron energy spectrum at energies much greater than kT becomes a Fermi spectrum, which cannot be satisfactorily represented by the product of the Maxwellian function and a linear combination of associated Laguerre polynomials. An expression involving the associated Laguerre polynomials and the related functions is developed. A method is proposed of determining the expansion coefficients giving a reasonably uniform approximation of the known function over the whole energy range. The rate of covergence of the expansion is studied by comparing the neutron spectra in an infinite homogeneous medium obtained by direct numerical calculation and by using the proposed expansion. Spectra are considered for media with different dimensions and different absorption laws and for various thermalization models. (auth)

30374 ENERGY-DEPENDENT BOLTZMANN EQUATION WITH FISSION AND SLOWING-DOWN KERNELS. Nicolaenko, B.; Zweifel, P. F. (Univ. of Michigan, Ann Arbor). pp 63-80 of Neutron Thermalization and Reactor Spectra. Vol. I. Vienna, International Atomic Energy Agency, 1968.

From IAEA Symposium on Neutron Thermalization and Reactor Spectra, Ann Arbor, Mich. See STI/PUB-160(Vol.1); CONF-670707-(Vol.1).

A study of the energy-dependent neutron transport equation, using Case's method of singular eigenfunctions and considering a continuous energy variable is presented. Both fission and slowing-down kernels are included in the analysis. Under the assumption of simple cross-section laws, and plane symmetry, a completeness theorem and the Green's function are found for the infinite medium, for both isotropic and anisotropic scattering, using rather general assumptions as to the slowing-down kernels and, only in the anisotropic case, the generalized Greuling-Goertzel kernel. The crux of the completeness theorem is the inversion and analysis of the spectral properties of a continuous operator which acts upon the energy variable, and depends parametrically upon a complex variable z. For half-space problems, the Wiener-Hopf factorization of such an operator is a remarkably difficult problem; however, it can be performed if, for the slowing-down kernel, the Greuling-Boertzel approximation generalized to all its anisotropic components is used; the Wiener-Hopf factorization then gives another convolution operator. In this approximation the Milne problem is solved, and a study is made of the extrapolation length. There is a discussion of the difficulties introduced by fission kernels, with emphasis on the coexistence of space-energy separable modes with slowing-down transient modes. 27 references. (auth)

30375 ASYMPTOTIC BEHAVIOUR OF NEUTRON TRANSPORT PROCESSES. Hejtmanek, J. H. (Technische Hochschule, Vienna). pp 81-93 of Neutron Thermalization and Reactor Spectra. Vol. I. Vienna, International Atomic Energy Agency, 1968.

From IAEA Symposium on Neutron Thermalization and Reactor Spectra, Ann Arbor, Mich. See STI/PUB-160(Vol.1); CONF-670707-(Vol.1).

The solution of the initial-value problem of the time-dependent linear Boltzmann equation corresponds to a semigroup of linear transformations. Lehner and Wing were the first to use a Laplace transform technique for the study of the asymptotic behavior of the solution. Mika, Bednarz, Albertoni, Kaper et al., extended this technique to more general problems. The main task is always to find the spectrum of the Boltzmann operator A. Asymptotic behavior is closely related to the point spectrum of A, if the latter exists. Mean ergodic theory, the study of asymptotic properties of semigroups of bounded transformations in a Banach space, is used for spectrum determinations. Two types of function spaces are considered; The Banach space L^1_m of functions integrable on the six-dimensional μ-space of statistical mechanics; the Hilbert space L^2_m of functions square integrable on the μ-space. Excluding the case of a super-critical system, the semigroup generated by the Boltzmann operator A is uniformly bounded. The splitting theorem of mean ergodic theory can then be applied. The initial distribution is split uniquely into a sum of a reversible and a flight vector. Now a special property of the semigroup generated by the Boltzmann operator A enters: there exists a characteristic time $t_0 > 0$ depending only on the geometry and chemistry of the system such that $T_t f(\vec{x},\vec{v}) > 0$ for all $(\vec{x},\vec{v})$, for all f and all $t \geq t_0$. From this property it is possible to deduce that an equilibrium distribution exists and is unique. Taking the Hilbert space L^2_m, criticality of a reactor corresponds to strong mixing in the sense of ergodic theory; we define a reactor as critical if for all f and all g, positive almost everywhere, a positive limit $(T_t f,g)$ exists for $t \to \infty$. This definition corresponds to the Fermi experiment. Boundedness of T_t can be demonstrated. Finally an attempt is made to define the mean entropy of a neutron transport process. 16 references. (auth)

30376 SLOWING-DOWN AND HEATING-UP OF NEUTRONS IN BERYLLIUM. Ghatak, A. K. (Indian Inst. of Tech., New Delhi); Goyal, I. C.; Grover, P. S.; Kothari, L. S. pp 223-32 of Neutron Thermalization and Reactor Spectra. Vol. I. Vienna, International Atomic Energy Agency, 1968.

From IAEA Symposium on Neutron Thermalization and Reactor Spectra, Ann Arbor, Mich. See STI/PUB-160(Vol.1); CONF-670707-(Vol.1).

The results of an extensive series of calculations made to understand quantitatively the approach to equilibrium of a high-energy neutron pulse and a low-energy neutron pulse, introduced inside finite beryllium assemblies, are given. After a high-energy burst of neutrons at time t = 0, we have calculated the neutron spectra at subsequent times, and these have been compared with the experimental results. The agreement is found to be very good. We have also studied the rate at which the average neutron energy and the average neutron velocity approach equilibrium. From these studies, the thermalization time has been deduced and the possibility of its experimental measurement is discussed. When a pulse of low-energy neutrons is introduced inside a moderating assembly, the average energy of the neutron distribution increases with time. For this heating-up process also, we have calculated the transient neutron spectra, the decay constant of the pulse and the heating-up relaxation time. Unlike neutron slowing-down, where equilibrium is reached faster in larger assemblies, in the heating-up case we find that equilibrium is reached faster for smaller assemblies. The possible reasons for this behavior are discussed. 18 references. (auth)

30277 STUDY OF INELASTIC NEUTRON SCATTERING IN GRAPHITE AT VARIOUS TEMPERATURES. Eremeev, I. P.; Mostovoi, V. I.; Sadikov, I. P.; Severov, M. N.; Chernyshov,

A. A. (Inst. of Atomic Energy, Moscow). pp 343-60 of Neutron Thermalization and Reactor Spectra. Vol. I. Vienna, International Atomic Energy Agency, 1968. (In Russian).

From IAEA Symposium on Neutron Thermalization and Reactor Spectra, Ann Arbor, Mich. See STI/PUB-160(Vol.1); CONF-670707-(Vol.1).

Results of measurements of the double-differential neutron scattering cross-section for reactor graphite for temperatures of 15, 490, 1000, and 1370°C are given. The measurements were made at the WWR-M reactor with an experimental device intended for studying the inelastic scattering of slow neutrons. Monochromatization and chopping of the primary neutron beam were achieved with the aid of a single crystal and a mechanical chopper. The scattered radiation is analysed in terms of energy using the time-of-flight method simultaneously for eight angles in the range 10 to 115°. The data obtained are represented in the form of the scattering cross-section which is compared with the result of calculations based on the frequency spectrum suggested by Egelstaff. 12 references. (auth)

30378 SCATTERING LAWS FOR HEAVY WATER AT 540°K AND LIGHT WATER AT 550°K. Haywood, B. C.; Page, D. I. (Atomic Energy Research Establishment, Harwell, Eng.). pp 361-72 of Neutron Thermalization and Reactor Spectra. Vol. I. Vienna, International Atomic Energy Agency, 1968.

From IAEA Symposium on Neutron Thermalization and Reactor Spectra, Ann Arbor, Mich. See STI/PUB-160(Vol.1); CONF-670707-(Vol.1).

Spectral density distributions have been calculated from scattering law measurements on heavy water at 540°K and light water st 550°K; these are compared with the light-water data at room temperature. The scattering laws over all energy and momenta transfers have been generated using the computer programme LEAP and discrepancies between the calculated and experimental results are discussed in terms of coherent and multiple scattering effects. The scattering law for light water at 550°K is used in the programme TRAP to calculate the total scattering cross-sections which are compared with the room-temperature data. 24 references. (auth)

30379 CALCULATED SCATTERING LAW AND THERMAL NEUTRON SPECTRUM FOR BENZENE. Marsden, R. S.; McMurry, H. L. (Idaho Nuclear Corp., Idaho Falls). pp 457-65 of Neutron Thermalization and Reactor Spectra. Vol. I. Vienna, International Atomic Energy Agency, 1968.

From IAEA Symposium on Neutron Thermalization and Reactor Spectra, Ann Arbor, Mich. See STI/PUB-160(Vol.1); CONF-670707-(Vol.1).

The Egelstaff scattering law has been calculated for benzene using a complete set of normal modes and associated characteristic vibrational energies. Intermolecular interactions have been neglected. The data compare favorably with the measurements of Glaser, Ehret, and Merkel except that for $\beta < 2$, the calculated functions fall below the data at low α values. This is attributed to neglect of intermolecular interactions. The total cross-sections calculated as a function of neutron energy are in good agreement with the data of Rush. Calculated values of the average cosine of the scattering angle, are generally a few percent higher than Hofmayr's data. A spectrum calculated for benzene poisoned to 5.9 b per H atom agrees fairly well with measurements made at General Atomic, although the calculated distribution is high for energies below the peak of the $E\phi(E)$ function. The calculated parameters, λ_0, D, and C, appearing in the equation, $\lambda = \lambda_0 + DB^2 - CB^4$, are higher than the results of Pal, Kisdi-Koszo, Szatmary, and Vizi; but λ_0 and C lie within the error limits given for the data. 19 references. (auth)

30380 MOLECULAR MODEL FOR POLYPHENYLS AND ITS USE IN CALCULATING REACTOR PARAMETERS. Ardente, V.; Cuniberti, R.; Kind, A.; Rossi, G. (EURATOM, Ispra, Italy). pp 467-76 of Neutron Thermalization and Reactor Spectra. Vol. I. Vienna, International Atomic Energy Agency, 1968.

From IAEA Symposium on Neutron Thermalization and Reactor Spectra, Ann Arbor, Mich. See STI/PUB-160(Vol.1); CONF-670707-(Vol.1).

A molecular model previously proposed to describe the slow neutron scattering by polyphenyls has been applied to the evaluation of spectral indices and thermal reactivity parameters in organic-cooled heavy-water lattices. To predict the interaction between slow neutrons and bound nuclei in polyphenyls in the single benzene molecule was regarded as the basic dynamic unit. The idea in this molecular model was to replace the very complicated and anisotropic vibrational spectrum of the average proton bound in the benzene molecule by a highly simplified isotropic one: two vibrational oscillators at 0.12 eV and 0.38 eV. Free molecular translations and hindered rotations are also included. The hindered rotations are formally replaced by a torsional isotropic oscillation with a single frequency at 0.02 eV and with a rotational mass $M_r = 21.3$. The model was able to predict successfully experimental results on integral scattering quantities for benzene and diphenyl at room temperature, showing in this way that such quantities are not excessively dependent on the structure of the molecule or on the vibrational details of various polyphenyls. It is, therefore, assumed that this model can be applied for a quantitative understanding of thermal reactor parameters. To investigate the sensitivity of the mentioned reactor quentities to the description of the neutron interaction the calculations have also been performed with the free-gas model. Two completely independent numerical methods for solving the Boltzmann transport equation are used. The aim is to compare the sensitivity to the scattering law with the differences in the results connected with the adopted numerical method, by using the same nuclear data library. The calculations concern such quantities as spectral indicies, coolant temperature coefficients, thermal fission and thermal utilization factors and are referred to a typical ORGEL lattice, with clustered uranium carbide fuel element. 12 references. (auth)

30381 EFFECT OF NON-UNIFORMITY OF SLOWING-DOWN FLUX ON THE RESONANCE INTEGRAL. Benoist, P.; Kavenoky, A.; Livolant, M. (CEN, Saclay, France). pp 591-602 of Neutron Thermalization and Reactor Spectra. Vol. I. Vienna, International Atomic Energy Agency, 1968. (In French).

From IAEA Symposium on Neutron Thermalization and Reactor Spectra, Ann Arbor, Mich. See STI/PUB-160(Vol.1); CONF-670707-(Vol.1).

The effect of non-uniformity of the flux in the moderator on the effective resonance integral is studied. This non-uniformity may result either from the localized presence of the fission-neutron source in the fuel, or from capture in the fuel at resonance energy. To calculate these effects use is made of a simplified slowing-down model, with which moderator and fuel can be treated separately, and which is characterized by a fundamental function. The basic approximations of this model are studied separately and numerical applications of the resonance integral corrections are given in a few special cases. (auth)

30382 MONTE CARLO ANALYSES OF TIME-DEPENDENT NEUTRON THERMALIZATION IN ORGANIC MODERATOR. Cupini, E.; Molinari, V. G. (CNEN, Bologna). pp 617-28 of Neutron Thermalization and Reactor Spectra. Vol. I. Vienna, International Atomic Energy Agency, 1968.

From IAEA Symposium on Neutron Thermalization and Reactor Spectra, Ann Arbor, Mich. See STI/PUB-160(Vol.1); CONF-670707-(Vol.1).

The slowing-down, thermalization and diffusion of a neutron pulse in benzene is studied by the Monte Carlo method. The time dependence of the neutron spectrum, total neutron density and spatial neutron distribution are obtained for homogeneous spheres as well as for infinite medium. The benzene scattering kernel was derived from the incoherent approximation assuming harmonic oscillation. The value of the diffusion coefficient obtained is in perfect agreement with the theoretical and experimental data. It is found that the neutron distribution for the sphere with radius R = 1 cm, shows a very different behavior in comparison with the spheres with R > 1.5 cm. It is likely that only a continuous spectrum of eigenvalues exists for R < 1.3 cm ($B^2 > 3.31\ cm^{-2}$). 11 references. (auth)

30383 NEUTRON RETHERMALIZATION STUDIES IN H_2O AND ZrH_2. Saastamoinen, J. (Technical Univ. of Helsinki, Otaniemi, Finland). pp 629-41 of Neutron Thermalization and Reactor Spectra. Vol. I. Vienna, International Atomic Energy Agency, 1968.

From IAEA Symposium on Neutron Thermalization and Reactor Spectra, Ann Arbor, Mich. See STI/PUB-160(Vol. 1); CONF-670707-(Vol. 1).

The theoretical model used for calculation of the neutron spectrum in the vicinity of a medium and temperature discontinuity is based on the presentation of every P_N-component of the flux as a combination of the two equilibrium fluxes with space-dependent amplitudes. If the two first energy moments of the P_N-equations are exact, and every component of the flux is continuous at the interface, then these amplitudes are determined. P_3-calculations in plane geometry have been performed for the systems of $H_2O(20°C) - H_2O(80°C)$. The results obtained for the Nelkin and the McMurry-Russell scattering models have been compared with the experimental results. The one relaxation length model cannot be used to describe the neutron spectrum. The three relaxation lengths given by the P_3-calculations are all smaller than $(\Sigma_1)^{-1}_{min}$. Thus it appears that no discrete relaxation lengths exist in light water. The apparent discrepancy between the results of several

experiments which have been reported can largely be attributed to the angle anisotropy of the spectrum. Measurements have been performed for the H_2O-ZrH_2-system by the chopper time-of-flight method using the thermal column of FiR 1 (TRIGA Mark II) as the neutron source and extracting the neutron beam from the water side at various distances from the discontinuity. The perturbation introduced by the extraction channel and the connection between the beam spectrum and the real spectrum is discussed. 22 references. (auth)

30384 DETERMINATION OF THE LUMPED HEAT-TRANSFER AND REACTIVITY COEFFICIENTS OF A NUCLEAR REACTOR. Obeid, Mohamed Abdel-Fattah. Charlottesville, Va., Univ. of Virginia, 1967. 181p.
Thesis.

Presented is a novel method of determining the lumped heat-transfer coefficients plus the temperature coefficients of reactivity of a nuclear reactor. No knowledge of the component temperatures is required, so that the method is particularly attractive in systems where temperatures cannot be monitored, or where uncertainties in temperature variations can produce large errors in experimental results. A mathematical model was developed for the reactor which was assumed to consist of lumped fuel, moderator, and reflector components. Equations were derived to permit an evaluation of the heat-transfer and temperature feedback coefficients, through a matching of the model to the frequency response, as obtained by pile oscillator techniques. The method was applied to the University of Virginia swimming pool reactor (UVAR). The lumped heat-transfer and reactivity coefficients for it were determined. The fuel and moderator temperature coefficients of reactivity were negative while that of the reflector was determined to be positive. The values for the fuel-to-coolant heat-transfer coefficient and the moderator coefficient of reactivity were within ±12% of the values calculated by independent methods. On the basis of these experimentally measured kinetic parameters, a complete study of the linear and nonlinear stability proved the inherent and asymptotic stability of the UVAR. This analysis was based on the mathematical model that was developed for the reactor, and assumed the feedback was linear. (TSS) (Disser. Abstr.)

30385 REACTOR MATERIALS. Volume 11, Number 2. Simons, E. M.; Porembka, S. W. Jr.; Keller, D. L. (eds.). One of Four Quarterly Technical Progress Reviews published for the Division of Technical Information, USAEC. Columbus, Ohio, Battelle Memorial Inst., Summer 1968. 66p. GPO $0.70.

Topics discussed include: fabrication and properties analysis of fuels and fertile materials; mechanical properties and testing results for moderator and control materials; corrosion effects of water, air, steam, and CO_2 on cladding and structural materials; and welding and fabrication techniques for metals. (D.C.C.)

For abstracts of individual sections see: 30386–30389.

30386 FUEL AND FERTILE MATERIALS. Reactor Mater., 11: 81-92(Summer 1968).

Mechanical properties and phase studies are presented for unalloyed uranium, α-phase uranium alloys, ϵ-phase uranium alloys, and γ-phase uranium alloys. Phase studies for the Pu–U–Zr system are presented. Ternary phase diagram studies for the O–Pu–U system are presented. Irradiation effects on Zircaloy-2 clad Th–U–Zr fuel elements are described. Thermal and mechanical properties of ceramic fuels are presented. Mechanical and thermal properties as well as fabrication techniques for uranium and thorium oxides and uranium carbides, nitrides, phosphides, and sulfides are described. The steam oxidation reactions of UO_2 are described. Irradiation effects on mechanical and thermal properties of metals and ceramics are presented. 61 references are included. (D.C.C.)

30387 MODERATOR AND CONTROL MATERIALS. Reactor Mater., 11: 93-101(Summer 1968).

Results from compressive loading tests of anisotropic and isotropic graphite are presented. Compression properties of commercial Be and ultrahigh-purity single crystals are described. Also, alloy properties of Be–Cu–Ni and Be–Cr–Zr are presented. Welding techniques for Be and beryllium alloys are described. Phase studies for zirconium hydrides, lithium hydrides, and yttrium hydrides are presented. Dissociation pressures for hydrided U–Zr alloys are listed. Pressure-composition isotherms are presented for hydrided zirconium alloys of ZrU_2, $ZrCr_2$ and $ZrMo_2$. Corrosion tests on binary alloys of hafnium are described. 29 references are included. (D.C.C.)

30388 CLADDING AND STRUCTURAL MATERIALS. Reactor Mater., 11: 102-33(Summer 1968).

Corrosion of aluminum alloys, stainless steels, zirconium alloys, nickel-base alloys, and tungsten by water, steam, and CO_2 is described. Corrosion of refractory metals by boiling K, Na, Li, Pb, Bi, and Sn is discussed. Results from water reaction to melted Zircaloy-2 clad UO_2 fuel elements are presented. Radiation effects on tensile properties of stainless steels and nickel alloys are described. Effects of annealing temperatures on stress properties of refractory metals are described. Stress properties for aluminum and zirconium alloys are presented. 130 references are included. (D.C.C.)

30389 SPECIAL FABRICATION TECHNIQUES. Reactor Mater., 11: 134-43(Summer 1968).

Melting and fabrication methods for uranium and metal alloys are described. Pressure bonding method for Al and stainless steel transition joint is described. A process for the nonelectrolytic deposition of Ti and Nb alloys from fused-salt baths is presented. Electroplating of Al is described. Techniques for making joints of SAP and stainless steel, ceramics and Ta, and steels are described. Ultrasonic methods for measuring the flow of fluids through pipes are presented. 61 references are presented. (D.C.C.)

30390 STUDIES OF INTEGRAL NEUTRON TRANSPORT METHODS FOR NUCLEAR REACTOR CALCULATIONS. Carlvik, Ingvar. Goteborg, Chalmers Tekniska Hoegskola, 1967. 15p.
Thesis.

Integral transport methods have gained an increasing interest for calculations of neutron flux distributions. Integral transport methods are suitable for calculations in systems which are small when measured in mean free paths. In the area of reactor calculations, this condition is usually fulfilled in calculations of flux distributions inside a lattice cell. A description of currently used computer programs for such calculations is presented. The calculation of neutron flux distributions in geometries of interest to nuclear reactors is described. The necessary formulae for application of integral transport theory to these geometries are derived, and the efficiency of the methods is illustrated by means of a large series of one group calculations. Some related subjects are also considered such as the finite cylinders and the critical problem for homogeneous spheres and infinite slabs. (auth) (Swed)

30391 VOPROSY TEPLOFIZIKI YADERNYKH REAKTOROV. (Problems of Thermal Physics of Nuclear Reactors). Novikov, I. I. Moscow, Atomizdat, 1968. 144p.

Thermal and physical properties of materials and heat transfer in nuclear reactors are covered. Experimental data are given on the mechanics of vapor formation during boiling, critical boiling in a large volume, and the circulation of underheated coolants in a reactor channel. Temperature damage to fuel elements, coolant velocity distribution, and hydraulic resistance in the rod bundle are discussed together with Na and water boiling under conditions of free convection and the assembly of nuclear reactor rods. (R.V.J.)

30392 CLADDED CERAMIC NUCLEAR REACTOR FUEL ELEMENT HAVING AXIAL VOID. Bain, Alastair S. (to Atomic Energy of Canada Ltd.). U. S. Patent 3,376,201. Apr. 25, 1966.

A nuclear reactor fuel element has a sheathing member of such thickness that it would be collapsible under the expected coolant pressures in a nuclear reactor if not forced against the surface of the fuel elements. The nuclear fuel is in the form of UO_2 pellets having an axial void. The fuel element is designed to be operated at a temperature so that the central portion of the fuel is in a plastic condition and swells into the axial void which is approximately 4% by volume and only sufficiently large to accommodate this expansion. (Offic. Gaz.)

30393 CONTROL OF NUCLEAR POWER REACTOR. Dahlgren, Joens Arthur (to Alfa-Laval AB). U. S. Patent 3,373,082. Jan. 11, 1966. Priority date Jan. 20, 1965, Sweden.

The reactor core contains fuel elements extending generally parallel to a central axis of the core and having respective longitudinal axes located at different radial distances from the core axis. A moderator fluid is fed into the core and between the fuel elements, and means are provided to mount each of at least some of those elements for rotation about only one axis which is offset from the core axis and is eccentric to and parallels the longitudinal axis of the element, whereby the quantity of moderator fluid between the fuel elements is variable. (U. S. Pat. Gazette)

30394 FLOATING ABSORBER SHUTOFF DEVICE FOR NUCLEAR REACTOR. Stubley, Philip H. (to Atomic Energy of Canada, Ltd.). U. S. Patent 3,375,170. July 8, 1966.

The description of a nuclear reactor shutdown device is pre-

sented. The device consists of a column of floating neutron absorbing spheres in a liquid-moderated reactor core. The column filled with moderating fluid supports the spheres above the core level of moderating fluid. The bottom of the column penetrates the core fluid level. Gas pressure and vacuum can be exerted in the column to regulate the level of the control spheres. (D.C.C.)

30395 FUEL ASSEMBLY FOR NUCLEAR REACTORS. Mansson, Ragnar; Skar, Harald (to Allmanna Svenska Elektriska Aktiebolaget). U. S. Patent 3,375,172. May 4, 1966. Priority date May 4, 1965, Sweden.

A nuclear fuel assembly having a number of parallel fuel rods spaced apart by cross-spacers and an axial spacer for determining the axial position of the cross-spaces is described. The fuel rods are supported by fixing plates, being secured to one and guided in holes in another. The axial spacer forms a supporting part of the fuel assembly, and all fuel rods are undivided; have no support function; and are alike with regard to their mode of connection and support. (U. S. Pat. Gazette)

30396 IMPROVEMENTS IN NUCLEAR REACTOR REFUELLING MACHINES. Stacey, John; Parker, Horace Frank; Smith, William Douglas (to United Kingdom Atomic Energy Authority). British Patent 1,112,384. May 1, 1968. Filed Feb. 12, 1965.

The description of a reactor refuelling machine is presented. The refuelling machine consists of a gripper unit located inside a hollow guide tube. When a fuel assembly is withdrawn from the core it is fully contained in the hollow guide tube. The gripper unit is driven by a screw and nut system. (D.C.C.)

30397 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTOR FUEL ELEMENTS. Eyre, Philip Bernard (to United Kingdom Atomic Energy Authority). British Patent 1,112,386. May 1, 1968. Filed Sept. 21, 1964.

The description of a plate type fuel element consisting of parallel plates brazed at the longitudinal edges between side plates is presented. The longitudinal edges have leak testing grooves connected to coolant transfer holes. (D.C.C.)

30398 IMPROVEMENTS RELATING TO NUCLEAR REACTORS. Prince, Michael John; Ainsworth, Geoffrey Douglas (to United Kingdom Atomic Energy Authority). British Patent 1,112,346. May 1, 1968. Filed July 28, 1965.

The description of a nuclear reactor containing a clustered fuel rod core with spaced guide tubes for control pins and coolant flow is presented. Control pins are driven into and out of the spaced guide tubes. Coolant is sprayed over the fuel elements from uniformly perforated guide tubes. (D.C.C.)

30399 IMPROVEMENTS RELATING TO NUCLEAR REACTORS. Frame, Alexander Gilchrist; Parker, Horace Frank (to United Kingdom Atomic Energy Authority). British Patent 1,112,383. May 1, 1968. Filed Aug. 28, 1964.

The description of a nuclear reactor consisting of a pressure vessel and a supported reactor core containing coolant flow channels and instrumentation columns is presented. The instrumentation columns are arranged in a cluster relative to coolant flow channels. A rotary shield is located a few inches from the end of the core support structure. The instrumentation channels are arranged so that the fuel handling device performs without interruption. (D.C.C.)

30400 METHOD OF INHIBITING THE CORROSION OF GRAPHITE IN A CO_2-COOLED NUCLEAR REACTOR. Koch, Charles; Ranc, Rene (to Commissariat a l'Energie Atomique). U. S. Patent 3,373,083. May 16, 1966. Priority date June 9, 1965, France.

The corrosion of graphite in a graphite moderated CO_2-cooled nuclear reactor is inhibited by adding about 0.2% by weight of SiH_4, Si_2H_6 or $Si(OC_2H_5)_4$ to the CO_2 coolant. (U. S. Pat. Gazette)

30401 NUCLEAR REACTOR CONTAINMENT SYSTEM AND RELIEF VALVE. Wilson, Ivan L. (to Atomic Energy of Canada Ltd.). U. S. Patent 3,375,162. Aug. 9, 1965.

A containment system for a nuclear reactor is described, in which the reactor may be subject to breakdown and release of gaseous radioactive materials into the surroundings. The reactor is enclosed in a gas-tight building and connected through a pressure relief valve to a vacuum building. A sub-atmospheric pressure is maintained in this vacuum building and the relief valve is made to open to connect the reactor and vacuum buildings if at any time the pressure in the reactor building, normally maintained at atmospheric, rises slightly above it. The volume of the reactor and vacuum buildings is so chosen with respect to the pressure maintained in the vacuum building that upon connection of the two buildings the pressure will not be above atmospheric for the worst possible breakdown contemplated. (U. S. Pat. Gazette)

30402 NUCLEAR REACTORS. Knights, Herbert Chilvers; Rodwell, William; Ainsworth, Geoffrey Douglas (to United Kingdom Atomic Energy Authority). British Patent 1,112,311. May 1, 1968. Filed Apr. 5, 1965.

The description of an integral nuclear reactor with a sealed header projecting through the reactor vessel is presented. The header has a movable plug for a seal. The header is a coaxial pipe that provides a sleeve for the plug and a coolant tube for best exchanger connections. (D.C.C.)

30403 PROCESS FOR THE FABRICATION OF FUEL ELEMENTS FOR NUCLEAR REACTORS. Blum, Pierre; Bochirol, Louis (to Commissariat a l'Energie Atomique). U. S. Patent 3,375,307. Jan. 17, 1966. Priority date Jan. 21, 1965, France.

A process for the fabrication of spherical fuel elements for use in high temperature reactors of the "pebble-bed" type is described. A kernel of fuel is prepared by molding a plastic paste of a refractory combustible powder having a granular size between 100 and 400 microns mixed with a binder, drying the kernel, then depositing pyrolytic carbon in the pores of the kernel by cracking gaseous hydrocarbons therein at a temperature between 800° and 1000°C, whereby the kernel is rendered impermeable. The kernel is coated with a layer of graphite using a paste formed in the same way as the paste forming the kernel, then gaseous hydrocarbons are cracked at a temperature between 800 and 1000°C, in the layer to deposit carbon in and render the layer impermeable. The coated kernel is introduced into a recess in a graphite ball, the ratio of resistance to compression of the kernel and of the layer being at least equal to 1.5:1. (Offic. Gaz.)

30404 VAPOUR QUALITY MEASUREMENT BY DELAYED GAMMA RADIATION EMISSION. Ward, Arthur G. (to Atomic Energy of Canada Ltd.). U. S. Patent 3,376,200. Aug. 26, 1966.

An apparatus for determining the quality of a coolant used in a nuclear reactor is described in which the coolant passes through the core of the reactor and is subjected to neutron irradiation. If the coolant contains a substance which undergoes delayed production of gamma radiation after the neutron bombardment, a detector past which the coolant is led after irradiation will detect the gamma radiation. The output from the detector is connected to a computer which calculates coolant quality on the basis of the signals from the detector and other chosen inputs dependent upon known conditions in the reactor. (U. S. Pat. Gazette)

GENERAL

30405 (BNWL-719) THERMAL MODIFICATION OF RIVER WATER QUALITY. Jaske, R. T. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Apr. 1968. Contract AT(45-1)-1830. 17p. Dep. CFSTI.

A study was made of the effects of hydraulic power dam construction on temperature changes in the Columbia River Basin. Experimental data from numerous stations were used to develop an environmental simulation model capable of predicting temperature and associated water quality variables to a high degree of accuracy. Conclusions regarding the temperatures of the Columbia River Basin within the U.S. were that: a temperature effect of less than 1°C over a 30 yr period from 1933 to 1966 had occurred; there is a lateral time shift in the thermal conditions in these waters, i.e., warmer waters in later fall months; any change in the river temperature persists throughout the water system; and a reduction in summer and fall water temperatures results from upstream impoundment. (L.C.L.)

30406 (COO-1712-2) THE USE OF THE ION ACTIVITY FUNCTION IN SOLUTION KINETICS. I. THE KINETICS OF HYDROCHLORIC ACID CATALYZED ESTER HYDROLYSIS. Leifer, Leslie; Williams, Fred D. (Michigan Technological Univ., Houghton. Dept. of Chemistry and Chemical Engineering). Mar. 15, 1968. Contract AT(11-1)-1712. 17p. (CONF-680308-5). Dep. CFSTI.

From 155th National Meeting of the American Chemical Society, San Francisco, Calif.

A study of acid-catalyzed hydrolysis reactions by use of the concentration of formal species in aqueous acid solvent systems is presented. This procedure resulted in more linear relationships when compared with previously accepted data. Where data were available, two distinct ester hydrolysis reactions were separated kinetically; one involving $H_3O_1^+$, the other H_3O^+. The acidity measurements and necessary thermodynamic data for the evaluation of acid profiles were obtained at 25°C. Results are presented for the hydrolysis of γ-butyrolactone, ethyl acetate, methyl formate, ethylidene, methylidene, and ethyl acetoacetate and the lactonization of γ-hydroxybutyric acid. (P.C.H.)

30407 (NYO-1480-87) INTEGRALS OF NONLINEAR EQUATIONS OF EVOLUTION AND SOLITARY WAVES. Lax, Peter D. (New York Univ., N. Y. AEC Computing and Applied Mathematics Center). Jan. 1968. Contract AT(30-1)-1480. 52p. Dep. CFSTI.

A general principle for associating nonlinear equations of evolutions with linear operators so that the eigenvalues of the linear operator are integrals of the nonlinear equation is presented. A striking instance of such a procedure is the discovery by Gardner, Miura and Kruskal that the eigenvalues of the Schroedinger operator are integrals of the Korteweg-de Vries equation. Also, the simplest case of a conjecture of Kruskal and Zabusky is proven concerning the existence of double wave solutions of the Korteweg-de Vries equation, i.e., of solutions which for $|t|$ large behave as the superposition of two solitary waves traveling at different speeds. The main tool used is the first of a remarkable series of integrals discovered by Kruskal and Zabusky. (auth)

30408 (NYO-2147-13, pp 28-52) CALCIUM-BINDING PROTEIN AND ALKALINE EARTH ABSORPTION. (New York State Veterinary Coll., Ithaca. Dept. of Physical Biology).

Vitamin D was shown to induce the formation of a calcium-binding protein in the small intestine and kidney of rachitic animals. This protein, abbreviated CaBP, may be involved in some fashion with the translocation of Ca across epithelial tissues. Considerable attention was given to several aspects of the protein, and detailed studies over this report period led to the following: demonstration of the presence of a vitamin D-dependent CaBP in the dog; demonstration of the presence of a vitamin D-dependent CaBP in the uterus of the laying hen, a tissue across which large amounts of Ca moves during egg-shell formation; the improvement of the mathematical treatment of CaBP assay data such that a straight line relationship now can be obtained when CaBP concentration is plotted against the degree of Ca binding; the purification of CaBP from chick intestinal mucosa by a combination of procedures; including ammonium sulfate precipitation, gel filtration on Sephadex G-100 and preparative discontinuous electrophoresis; the determination of some of the physical and chemical properties of CaBP, prominent among these being the determination of molecular weight by two procedures which gave values ranging from 24,000 to 28,000, and the measurement of a formation constant which yielded values of 2.6×10^5, 3.9×10^4 and 5.9×10^3 M^{-1} for Ca, Sr and Ba, respectively; the correlation of the concentration of CaBP in intestinal mucosa with several physiological and nutritional variables that alter the ability of chick intestine to absorb Ca. (auth)

30409 (NYO-2356-29) STUDIES OF THE EFFECTS OF ULTRAVIOLET RADIATION ON CELL STRUCTURE AND BEHAVIOR. Annual Progress Report, December 1966-December 1967. Freed, Jerome J. (Institute for Cancer Research, Philadelphia, Pa.). Jan. 2, 1968. Contract AT(30-1)-2356. 14p. Dep. CFSTI.

CELLS—genetics, morphology, and reproduction of cultured frog embryo; reproduction of cultured rat liver; effects of arginine on chromosomes of cultured rat liver, genetic
CELLS, HELA—phagocytosis processes in, effects of colchicine and development of microtubules on
MICROSCOPES—development of vibrating-mirror, flying-spot, UV-, for visualization of nucleoproteins in cells

30410 (NYO-3401-4) ENERGY TRANSFER IN CHEMICAL AND BIOLOGICAL SYSTEMS. Progress Report, March 1967-February 1968. Lee, John (New England Inst. for Medical Research, Ridgefield, Conn.). Contract AT(30-1)-3401. 43p. Dep. CFSTI.

Some physical chemical aspects of the bioluminescence of bacteria and dinoflagellates, and of the chemiluminescence of luminol are reported. Several preparations of luciferase from the bioluminescent bacteria, Photobacterium fischeri, were highly purified. There appeared to be no bound moities having absorption or fluorescence that are required for the enzyme activity. Several models for the in vivo bioluminescence mechanism of the marine dinoflagellate, Conyaulax polyedra, were examined with regard to the relevance of the particulate enzyme system which can be obtained in extracts. Recent results of studies on the chemiluminescent reactions of luminol and the spectral characteristics of the product molecule, 3-aminophthalate ion, are briefly described. (auth)

30411 (ORNL-4100, pp 117) GENERAL PHYSIOLOGY. (Oak Ridge National Lab., Tenn.).

SCHIZOMYCOTA—Escherichia coli, mitosis in, effects of cell extracts on (H.L.W.)

30412 (ORNL-4100, pp 141-5) CELL PHYSIOLOGY. (Oak Ridge National Lab., Tenn.).

SCHIZOMYCOTA—Escherichia coli, survival of, effects of sodium chloride and temperature on; Saccharomyces cerevisiae, survival of, effects of temperature on
BACTERIOPHAGES—survival of, effects of freezing and thawing and water activity of salt solutions on (H.L.W.)

30413 (ORNL-4100, pp 146-7) NUCLEIC ACID CHEMISTRY. (Oak Ridge National Lab., Tenn.).

NUCLEIC ACID, RIBO—content of nucleosides in, of bacteria and yeasts, analysis of
TEMPERATURE, MAGNESIUM IONS—effects on interactions of adenine oligonucleotides with polyuridylic acid (H.L.W.)

30414 (ORNL-4100, pp 148-51) NUCLEIC ACID ENZYMOLOGY. (Oak Ridge National Lab., Tenn.).

EUMYCOTA—Neurospora sp., isolation of mitochondria from, use of sucrose gradient zonal centrifugation for; Neurospora sp., content of aminoacyl-RNA synthetase and tRNA in mitochondria of
SCHIZOMYCOTA—Escherichia coli, repair of DNA in phage-infected, effects of DNA nucleotidyltranaferase on; Escherichia coli, content of DNA in endonuclease from phage-infected; Escherichia coli, content of DNA oligodeoxynucleotidyl transferase in extracts of phage-infected
NUCLEIC ACID, DEOXYRIBO—synthesis of, effects of chloramphenicol and 5-fluorodeoxyuridine on; phosphorus-32 incorporation in bacteriophage
NUCLEIC ACID, RIBO—synthesis of, effects of chloramphenicol on; determination of nucleotide sequence in transfer
CRUSTACEA—Artemia salina, synthesis of adenine derivatives by nauplii of (E.R.B.)

30415 (ORNL-4100, pp 165) MICROBIOLOGY. (Oak Ridge National Lab., Tenn.).

SCHIZOMYCOTA—Micrococcus actilyticus, kinetics of malic-lactic transhydrogenase activity in (H.L.W.)

30416 (ORNL-TM-2180) ELECTRICAL CONDUCTIVITY OF MOLTEN FLUORIDES. A Review. Robbins, G. D. (Oak Ridge National Lab., Tenn.). Mar. 26, 1968. Contract W-7405-eng-26. 26p. Dep. CFSTI.

A review of electric conductivity measurements in molten fluoride systems covering the period 1927 to 1967 was made, with particular emphasis on experimental approach. It is pointed out that the common practice of measuring resistance with a Wheatstone bridge having a parallel resistance and capacitance, R_p and C_p, in the balancing arm can result in considerable error if the relation $R_p = R_s [1 + R_p^2 C_p^2 (2\Pi f)^2]$ is not employed in determining the solution resistance, R_s. The frequency dependence of the measured resistance and the practice of extrapolating measured resistances to infinite frequency versus $1/\sqrt{f}$ is examined in terms of electrode process concepts. A summary of experimental approaches and results for 56 molten fluoride systems is presented. (auth)

30417 (TID-24205) ENIWETOK MARINE BIOLOGICAL LABORATORY. Annual Report, 1966-67. Hiatt, Robert W. (Hawaii Univ., Honolulu). May 1, 1967. Contract AT(29-2)-226. 25p. Dep. CFSTI.

ENIWETOK ATOLL—ecology of land and sea animals at (E.R.B.)

30418 (UCRL-17852) USE OF A NITROXIDE RADICAL AS A TEST REAGENT OF THE PRIMARY PROCESSES OF PHOTOSYNTHESIS. Corker, Gerald Aloysius (California Univ., Berkeley. Lawrence Radiation Lab.). Sept. 1967. Contract W-7405-eng-48. 209p. Dep. CFSTI.

Thesis.

Work is reported on an attempt at identifying photo-induced paramagnetic species in photosynthetic organisms using ditertiarybutylnitroxide, a stable free radical, as a test reagent. Spinach chloroplasts sensitize a photo-reduction of the nitroxide to the corresponding hydroxylamine. Oxygen is produced from H_2O concurrently with the reduction in a ratio of one mole of oxygen evolved to about four moles of the nitroxide reduced. The reduction appears to be coupled with photosystem II in the chloroplasts. Also, the following reagents inhibited (or partially inhibited) the reaction: 3-(3,4-dichlorophenyl)-1, 1-dimethylurea; 2,6-dichlorophenol-indophenol (reduced or oxidized form); salicylaldoxime; and potassium ferricyanide. The photo-reduction, that was shown to occur with fresh chloroplasts, fresh fragments or aged fragments, was accompanied by a dark reaction that involved a reduction of the nitroxide. The reduced form of the nitroxide, ditertiarybutylhydroxylamine, underwent a photo-oxidation with spinach chloroplasts. It is proposed that the amount of the hydroxylamine photooxidized is controlled by the amount of an indigenous oxidant present in the chloroplasts and that this oxidant, though coupled to electron transport, is not an actual participant and is irreversibly reduced. A product that could be ascribed to a coupling reaction between the nitroxide and the radical species that gave rise to the photo-induced EPR signal in spinach chloroplasts was not detected; nitroxide was not suitable as a trapping agent. Nitroxide, oxidation by potassium ferricyanide to isobutene and 2-methyl-2-nitrosopropane, was complicated by a photochemical degradation of the nitroso compound. A reversible photo-reaction between the nitroxide and various quinones appeared to involve the formation of a di-peroxide type molecule resulting from the interaction of the nitroxide with the triplet states of the quinones. A widely accepted mechanistic view of photosynthesis, a review of the experimental electron paramagnetic resonance observations obtained with photosynthetic organisms, a brief investigation of charge-transfer complexes formed between pentafluorobenzonitrile and hexafluorobenzene with the organic bases, N,N,N′,N′-tetramethyl-p-phenylenediamine and dimethylaniline, and a discussion of an improved method for the detection of tritium combining the techniques of thin-layer chromatography, scintillation counting and radioautography are also included. (auth)

30419 (Y-1607) AUTOMATION OF A LONGITUDINAL-COMPARISON THERMAL CONDUCTIVITY APPARATUS. Williams, T. L.; Pate, J. L. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). May 7, 1968. Contract W-7405-eng-26. 54p. Dep. CFSTI.

A digital computer has been used to automate a longitudinal-comparison thermal conductivity apparatus. The computer is used to control temperatures inside the device and to store data for future readout when all specified conditions have been satisfied. The computer reduces the time necessary to acquire data, and it allows use of the apparatus during off shifts when no personnel are present. (auth)

30420 ANNUAL REPORT OF JAPAN ATOMIC ENERGY RESEARCH INSTITUTE FOR FISCAL 1966. Tokyo, Japan Atomic Energy Research Inst., 1967. 223p. (In Japanese).

The annual report of JAERI is given in the following sections: research and development (power reactors, reactor physics and engineering, fuels and structural materials, basic studies, health physics, radioisotopes, radiation chemistry); operation of the facilities (JRR-1, -2, -3, and -4, JPDR, JMTR, etc.); service works, etc.; construction works; and so on. (NSA of Japan)

30421 MAGNESIUM AND STRONTIUM IN CALCAREOUS SKELETONS: A REVIEW. Dodd, J. Robert (Indiana Univ., Bloomington). J. Paleontol., 41: 1313-29(Nov. 1967).

Considerable effort has been expended recently in studying trace and minor element chemistry of skeletal carbonate materials. These elements could be included in the skeleton in the following forms: substitutes for Ca in the calcite or aragonite crystal lattice; constituents of separate mineral phases; surface-adsorbed elements; or constituents of organic compounds. The concentration of Mg and Sr in carbonate skeletons was controlled by four major factors: Water chemistry (other factors being equal, the Mg/Ca and Sr/Ca ratios in skeletal material should be constant relative to those ratios in the water in which they formed), other environmental factors (Mg showed a strong positive correlation with temperature in calcitic skeletons, lesser temperature and salinity effects were noted for Sr in calcites and aragonites and possibly Mg in aragonite), mineralogy (calcite was generally high in Mg and low in Sr relative to aragonite), and physiology of the organisms (in general, the phylogenetically more advanced forms had lower Mg and Sr values). Skeletal chemistry could also vary between genera and families within a given major group. The mechanisms of physiological control of Mg and Sr were not understood, but isolation of the calcification site and growth rate could be involved. Among the applications of skeletal chemical data were uses in studying carbonate sediment chemistry, diagenesis of fossils and carbonate rocks, paleoecologic interpretations, geochemical cycles, and history of sea water chemistry. (BBB)

30422 PHYSICS OF DESALINATION BY MULTI-STAGE FLASH DISTILLATION. Silver, R. S. (Glasgow Univ.). J. Brit. Nucl. Energy Soc., 7: 36-42(Jan. 1968).

From Joint Symposium on Nuclear Desalination, London. See CONF-671054.

The adoption of sea-water distillation as a means of fresh water supply is a decision to be made on economic grounds, but the costs are determined largely by knowledge of the physical phenomena involved in the process, and by skill in controlling and exploiting these phenomena. The major physical aspects and their interaction with plant design and cost are reviewed. (auth)

30423 SURVEY OF PRESENT AND FUTURE DESALINATION PROCESSES. Johnson, K. D. B. (Atomic Energy Research Establishment, Harwell, Eng.). J. Brit. Nucl. Energy Soc., 7: 27-35(Jan. 1968).

From Joint Symposium on Nuclear Desalination, London. See CONF-671054.

The trend in flash distillation plant development is summarized, and the potential of competitive or alternative processes, particularly freezing, reverse osmosis and electrodialysis, both in the UK and overseas, is discussed. Flash distillation is in a commanding position, but there are reasons for believing that other processes are capable of development to the point where they will replace distillation in many circumstances. (auth)

30424 KAERNENERGIARBETET I NAGRA LAENDER OCH INTERNATIONELLA ORGANISATIONER. (Work on Nuclear Energy in Some Countries and International Organizations). Sandstroem, Sten (ed.) Stockholm, Aktiebolaget Atomenergi, 1968. 202p.

Work on the peaceful use of nuclear energy is briefly described for the following countries: Belgium, Canada, Denmark, France, German Federal Republic, Japan, the Netherlands, Norway, Switzerland, United Kingdom, and the United States. Activities within the following international organizations are also reviewed: European Nuclear Energy Agency (ENEA), European Atomic Energy Community (EURATOM), and International Atomic Energy Agency (IAEA). (Swed)